INTEGRATED EDITION OF THE PETROLEUM ENGINEER

the Petroleum Engineer

FOR MANAGEMENT

MARCH 1960

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ONE DOLLAR PER COPY

ALGERIA—SAHARA

GLOBAL NOTEBOOK

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Deep Wells Make Great Record

Exclusive 14th Annual Survey shows high discovery rate.

Process Plant Engineering Report

Plant layout, manpower scheduling and construction safety.

Corrosion And How To Control It

Roundup of modern methods on cathodic protection.

HOW MANY PROGRESSIVE IDEAS CAN YOU SPOT AT THIS DOWELL FRAC JOB?

Fracturing has come a long way in the past 10 years. And new ideas continue to improve this method of well stimulation. Pictured above are just four of the contributions Dowell has made to help you get more oil through better fracturing. *Allison aircraft engine-powered pumpers*—compact, powerful. *Remote control panels*—for safer, exacting control of the job. At the well, the special *frac header*—for more safety, efficiency. The new *radio helmets*—for even better control of the job. Not shown, but also important: *Abrasijet,** abrasive perforating service—to reduce breakdown pressures; and the *"Frac Guide"** —for really precise engineering of treatments. New ideas . . . more for your money . . . *dial Dowell.* Dowell, Tulsa 1, Okla.

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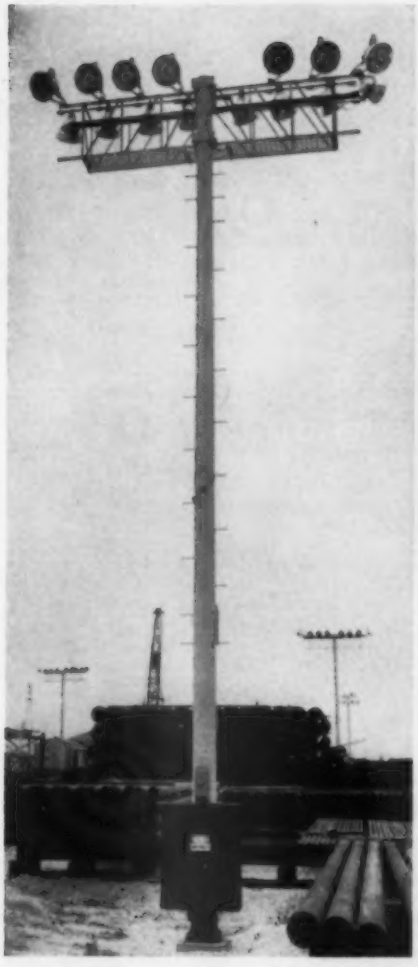
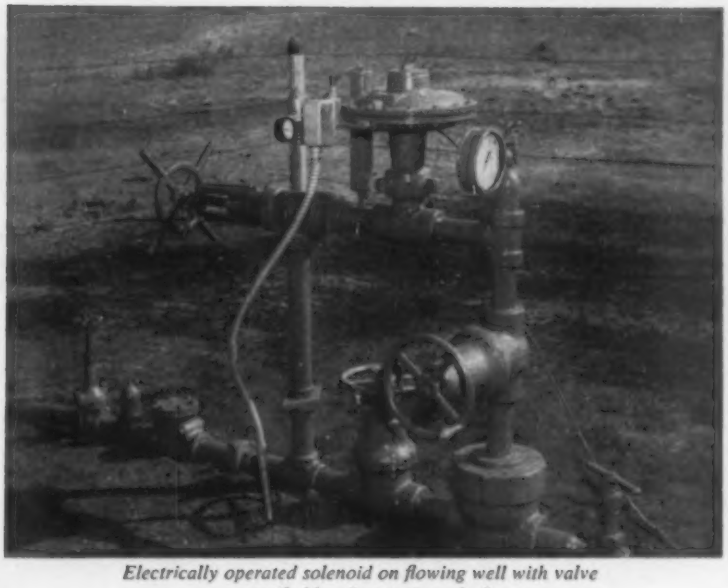
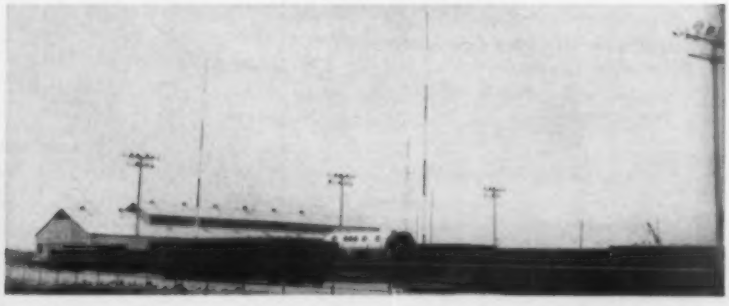




Electrically operated solenoid on flowing well with valve controlled by electric time-clock.



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THE PETROLEUM Engineer

FOR MANAGEMENT

NUMBER 3 • VOLUME XXXII • MARCH, 1960

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"A sound human being takes on a responsibility commensurate with his powers."

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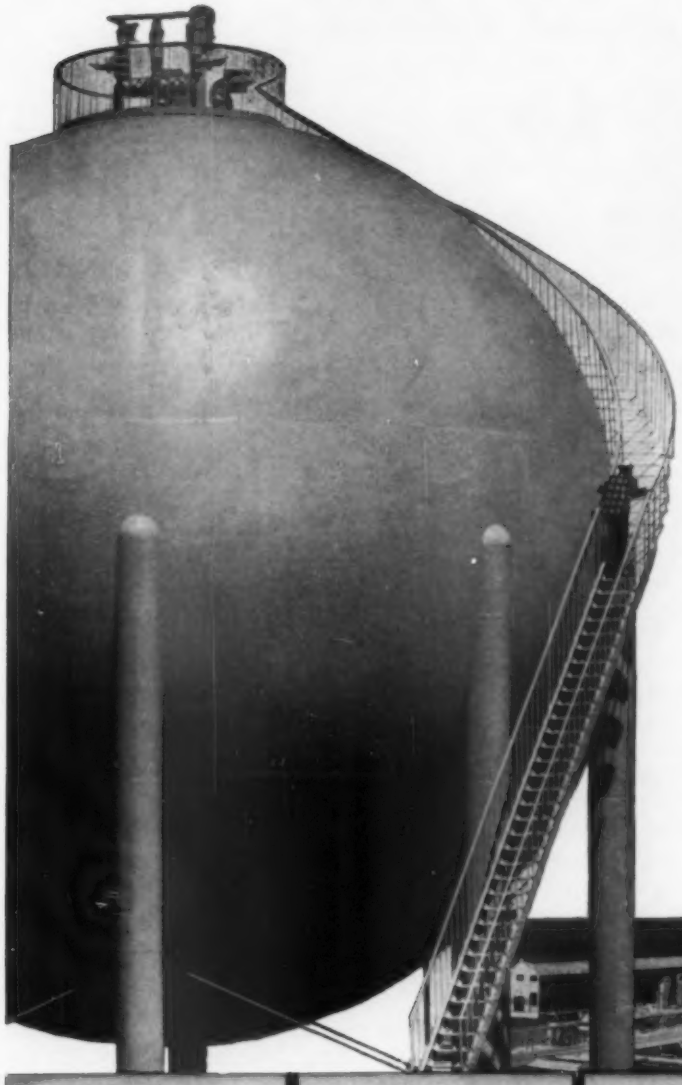

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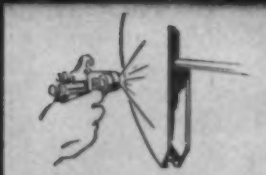

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What Can We Do To Be Saved . . .

. . . FROM TAX ANNIHILATION? The more efficiently the petroleum industry runs its business — the cheaper we offer products to the customer, the more they cost. Some government — state, local or federal — jumps at the margin of saving to the customer, and devours it.

Recently a new tax was levied on fuel oil in a Scandinavian country. The proponents' argument was that the cost of fuel oil had gone down so the buyer would not have to pay more — his payment would simply be to the government instead of to the oil company that had made the savings possible.

That is the story of our lives. We bear taxes on efficiency and incentive — taxes that defeat the progress that we spend millions on research and engineering to attain.

The *Dallas Morning News* conducted a survey recently in which one question was: "Of all the things you buy or the services you pay for, which one irritates you most because of high prices?" On that list of irritating high prices gasoline came fifth. *It received more mentions than taxes!* Yet the cost of a gallon of gasoline when it gets to the customer is more than half taxes. And President Eisenhower called for another ½ cent a gallon federal tax on gasoline in his recommendations to Congress.

WHEN A PERSON'S ENERGY is severely taxed, he is susceptible to illness — he's not much good to himself or anyone else. The oil and gas industry's energy isn't so different. The constantly increasing taxes have made even its dynamic health slow down. It can't take the bumps it once bounced over. It's getting hazardous to do more than plod along.

The tax situation says to the petroleum industry: Why spend funds on research and technology to improve products and make them available more widely and more cheaply? Taxes will go up faster than you can bring prices down or keep them level in the face of rising costs. Your customers pay more anyway and the majority never realize they don't pay it to you.

What can we do to be saved from a tax situation that is throttling our full speed ahead? We're sorry it's the same old answer — that there isn't some miracle way. It's the same old fighting method — you use *patient explanations to customers, letters to the President and Congress, speeches and telephone calls and telegrams.*

Are you too tax-loaded to care? If you are, then expect more taxes. That is the path of history and the trend of the future. The API, your advertising agency, none of your organizations can do it for you. You're not alone but you're on your own.

THE ENERGY YOU SUPPLY — the energy of progress — moves sluggishly. It has to take on more than its cost in taxes before it gets to work in the world on its own purpose of making the wheels of progress turn. No energy has been able to do that very long.

In the Soviet all stops are out to develop oil and gas. In this United States, oil and gas taxes supply funds to develop its competitors — water and atomic energies — and to build highways so food and furniture can be trucked in and military movements made more convenient. And now the coal industry wants chains applied to petroleum so they can stay in the race as energy suppliers!

It was an explosion of progress while we lasted. Now, should we go back to hunting whales?

Ernestine Adams

Congrats and $25 to R. STROHMEYER, J. M. Huber Corp., Borger, Texas

When it comes to blowing our own horn . . . We believe it is done best by delivering pipe of quality, stamina and dependability. Lone Star, the oil country's own steel mill . . . does just that on a round-the-clock basis.

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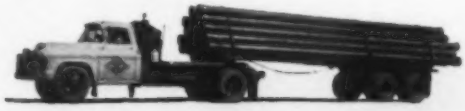

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

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THIS INDEX IS PROVIDED AS AN ADDITIONAL SERVICE FOR OUR READERS — THE PUBLISHER ASSUMES NO RESPONSIBILITY FOR ERRORS OR OMISSIONS

The new *Century* Pumping Units . . . designed by you for tomorrow's pumping!

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Wearing parts, such as gears, bearings, equalizer pins and wrist pins, are carefully engineered with adequate capacity for heavy-duty service. Positive grease or oil lubrication systems are provided to minimize wear and simplify maintenance procedures.

Roll-Back Arc is generously designed to provide full support, and its track-type face spaces the arc cables for easy installation of sucker rod rotator or dynamometer, either above or below the yoke. The slant-slot yoke simplifies installations and removals.

The Type G Cranks make maximum use of counterweights and are easier than ever to adjust, with operator working safely to the side of the unit and always having positive control of the weight. Height of the reduction-gear subbase allows the weights to clear the floor with several inches of safe toe room.

Routine maintenance is done at ground level. When the samson post-ladder is used, a welded and braced safety loop supports the mechanic.

With every wanted feature indicated by composite opinion, these new *Century* Pumping Units set new standards—in ease of maintenance as well as in performance.

For further information write or ask for a free copy of our booklet, *"A new Century."*

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Petroleum Profile

A. HOFLAND

Managing Director

Shell International Petroleum Company

THE NEWEST MANAGING DIRECTOR of Royal Dutch Petroleum Company is a man who started his business career as a farmer and had no thoughts of going to oil. Today, in addition to this latest directorship, he is also a principal director of the board of Bataafse Petroleum Maatschappij and a managing director of Shell International Petroleum Company, Ltd.

Born in Holland, Mr. A. Hofland took his doctorate in chemistry at Amsterdam University in 1925, and then bought 5000 acres of land in Corsica. He made a reasonable living farming but he could not see farming in Corsica building up sizable capital for a long-term future.

He returned to Holland at the end of 1928 and took stock of the business world. Among offers he received was one from Royal Dutch, then as now looking for technically qualified young men. His first reaction was negative. How could one rugged individualist hope to get to the top of so large an enterprise?

"You can become a director," he was told. "*Anybody* can become a director." Hofland returned to his Corsican farm to ponder for a while, and then decided to take the job. After a period in the Amsterdam laboratories Shell sent him to Germany to study lubricants marketing. In three months he reported that he had completed his course, and learned Spanish in the bargain.

"Very well," he was told, "then you can go to England and sell bitumen." His first assignment took him to paper factories all over Europe with a new bitumen coating for paper and a new kind of white asphalt flooring. (Incidentally, when he visited Vienna quite recently, he found the floors he had helped to lay nearly 30 years ago still in good condition.)

In 1933 a certain Mr. Godber (now Lord Godber, chairman of Shell Transport and Trading) picked Hofland to be the right hand man of the head of the distribution and supply department of the Asiatic Petroleum Company Ltd. Later he moved to a post in the operations department concerned with the development of service stations.

In 1939 Mr. Hofland was appointed to the management of "Nafta" Societa Italiana pel Petrolio ed Affini (now Shell Italiana). When World War II began in May 1940 he decided that his place was with his countrymen in the Netherlands. However, Dutch resistance had ceased before he arrived and Mr. Hofland was ordered to London where company executives had been evacuated from The Hague.

There he found the British capacity for understatement undimmed by military adversity. The colleague to whom he presented himself showed no desire to hear an account of his odyssey. "I thought we had lost you, old boy," he said laconically. "What would you like to do now?" In fact, he joined the staff of Mr. J. B. Aug. Kessler, now chairman of directors of the Royal Dutch.

By 1943 the material needs of the countries due to be liberated were being considered by a committee set up by Sir Anthony Eden, the then British Foreign Secretary. Hofland was recommended by The British Ministry of Fuel and Power as the best man to go to Italy and advise the Allied military authorities on oil matters. At first there were some raised eyebrows at a Dutch citizen being chosen for the post, but General Eisenhower himself said: "If he knows oil and can speak Italian, that's all that matters."

Hofland eminently fulfilled both these conditions, and in the autumn of 1943 he was flown in secrecy to Naples, via Gibraltar and Algiers. His contribution to the rehabilitation of the Italian civil economy by restoring the flow of oil is acknowledged in part of the official citation which accompanied the award of the United States Medal of Freedom with Bronze Palm later made to Hofland by the U. S. Government for "exceptionally meritorious conduct in the performance of outstanding services."

After the war in Europe ended Mr. Hofland was appointed oil adviser to the Allied Military Government in the British zone of Germany. He looked after Royal Dutch/Shell interests in addition, and in 1948 he was appointed general manager of Deutsche Shell A. G., the company he had done so much to get on its feet again. In that year Mr. Hofland was awarded the O.B.E. (Civil Division) for his services as petroleum adviser to the British Government. The Netherlands Government made him an Officer in the Order of Oranje Nassau and the Italians a Commander of the Order of Merit of the Republic of Italy.

Mr. Hofland returned to London in 1950 as manager of the European Area Department at St. Helen's Court. In 1955 the possibility held out to him a quarter of a century earlier became reality with his appointment as a director of The Shell Petroleum Company. This year the chemist from Amsterdam became a managing director, on the retirement of Mr. F. A. C. Guepin.

Mr. Hofland is married and has three daughters. Off duty he likes to read (particularly biographies), swim, and play a little tennis. He has had a life-long passion for classical music, accumulating in the process two of the largest private collections of gramophone records anywhere. The first was destroyed by a chance R.A.F. bomb in Genoa in 1941. The second, consisting of more than 1000 records of orchestral and operatic music, he recently presented to the Dutch Church in London. Now he is building up a third, refreshed by seasonal visits to the English operatic shrine at Clyndebourne, and by constant concert going.

Golf, traditional solace of businessmen, he intends to keep for retirement. "It takes up too much time," he says.

Special report to Caterpillar D8 Tractor owners:

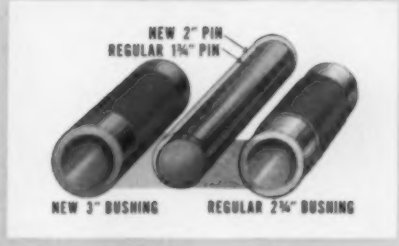
CAT CATERPILLAR

Parts you can trust
Dependable round-the-clock service

NEW TRACK COMPONENTS AVAILABLE FOR MOST D8 TRACTORS... GIVE UP TO 44% LONGER LIFE

Caterpillar's continuous research and testing pay off for you with the development of superior D8 track components. The next time you replace track parts, specify these new components. They last longer and require less maintenance. Here's what's available for 2U, 13A, 14A and 15A tractors:

30% STRONGER PINS AND BUSHINGS have more wear area to extend life. The big track pins are ¼" larger in diameter and heat-treated deep to resist wear . . . pins will not bend and cause uneven wear. The large contact areas of the bushings are hardened deep, both inside and out. Under field conditions these bushings have lasted up to 44% longer than regular bushings.



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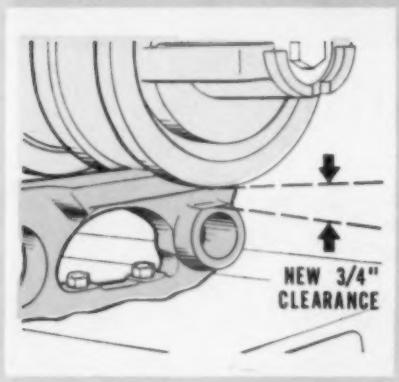
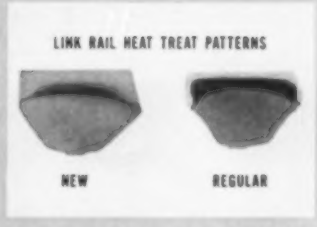


STRONGER, LONGER, HIGHER TRACK LINKS are 3 lb. heavier, 1" longer and ¼" higher. New length means fewer track sections are required. Increased height gives up to ¼" more *link pin boss-roller flange* clearance. Improved steel used in these links permits 80% deeper rail hardening and greater strength—pins and bushings stay tight *in the links* even under the roughest application.



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NEW TRACK SHOE GROUSERS ARE 20% THICKER at the tip and are hardened much deeper than on regular shoes. The new shoe as a whole is bigger and heavier to resist bending, impact and wear. Track hardware used with the new track components is stronger—bolt diameter increased from ¾" to ⅞".

• • •

NEW DESIGN BORALLOY SPROCKET REPLACEMENT RIMS are available to accommodate the increased pitch of the longer links and bigger track bushings. Teeth are precision-machined to provide exact fit with track bushings—a major contribution to longer bushing life.

SEE YOUR CATERPILLAR DEALER for more information on extending your D8 track life. He has parts you can trust and round-the-clock service. See him today.

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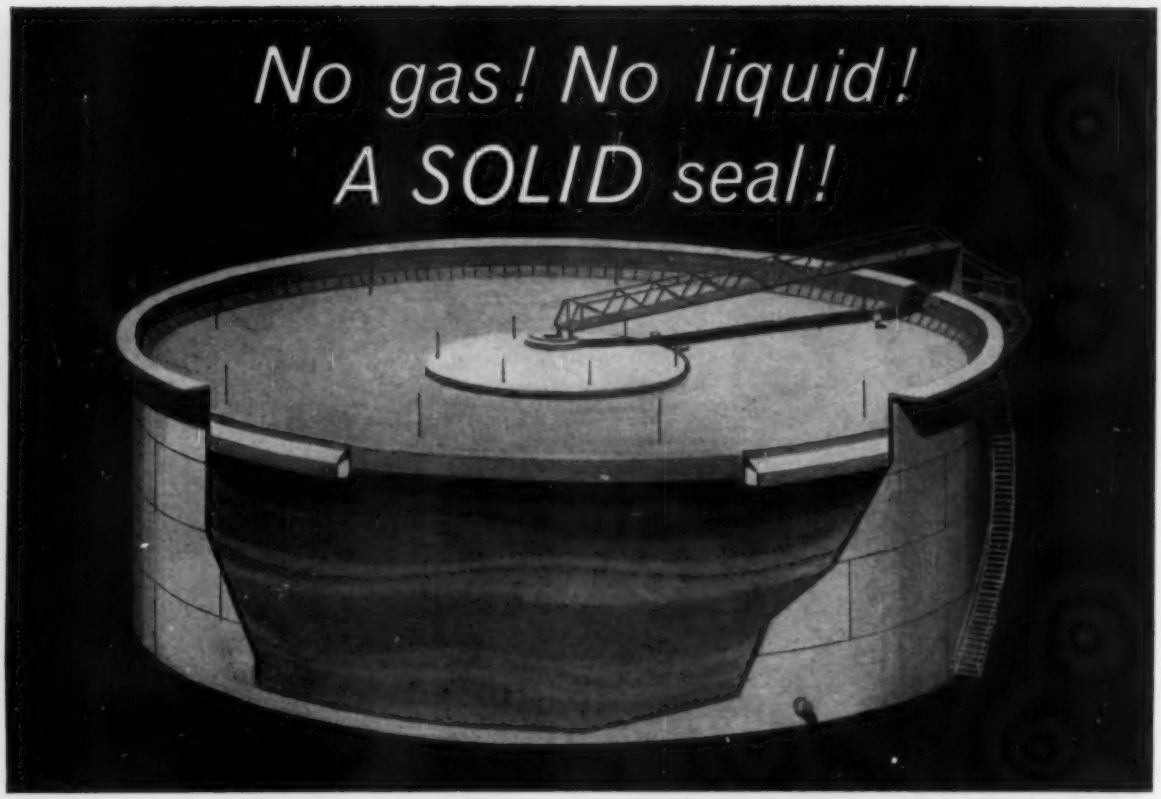

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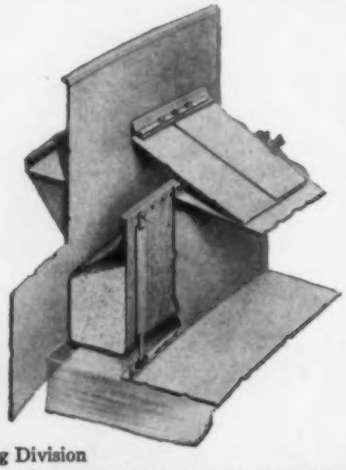
General American's new cushion seal for floating roofs

Tear it! Gouge it! Puncture it! The seal will hold. No matter what the damage, it will not burst or rupture! There's nothing in EVERSEAL to spill or leak.

Urethane cushions firmly joined and enclosed in a vapor-tight, no-scuff envelope of BUNA "N" and PVC are protected by the General American weather hood.

EVERSEAL resists the abrasive action of rough tank walls, yet will not scratch or damage tank coatings.

Get the complete details about EVERSEAL! Write the General American office nearest you. For any type of conservation structure, *it pays to plan with General American.*



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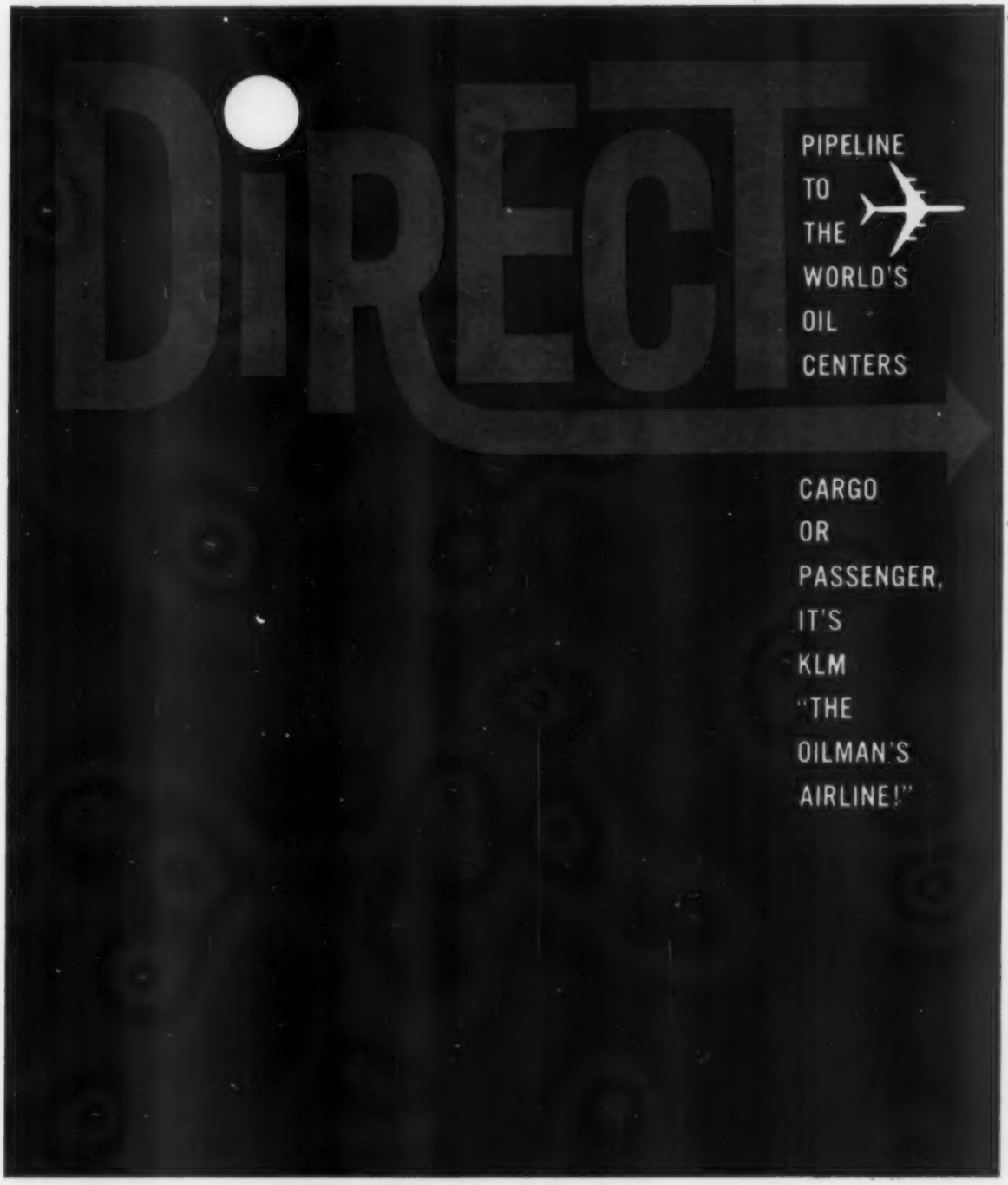

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Highlights and footnotes

TO TAP BIGGEST RESERVES . . . SWISS PREFER SCENERY . . . CRUDE OIL PRICE DOWN IN 1959 . . . ANOTHER FEDERAL CASE DROPPED . . .

40 Billion barrels. A new try to find an extraction method for Athabasca oil sands is under way. Imperial, Cities Service, Richfield (each 30%) and Royalite (10%) have joined in a research project to tap the Canadian sands, said to contain some 40 billion bbl of oil.

Imports push runs. Defects in import control plan have encouraged high refinery output and are partly responsible for weak price structure, is opinion of Robert L. Milligan, president, Pure Oil. Nonetheless he says the oil industry is a growth industry, second to none in vitality.

Who's to blame? In the new steel contract, companies agreed to require employees in states with "right to work" laws to pay a service charge to union officials equal to regular union dues. This is not exactly the way to influence people affected toward either side.

Up and down. Bureau of Mines released a preliminary review of 1959 on January 1. (That's news.) It stated average value of crude oil in 1959 was $2.94/bbl, down 7¢ from 1958. Marketed natural gas price increased slightly, from 11.9 to 12.1¢/Mcf.

Educational backing. Every large petroleum company and many small ones are in the education business. They invest their capital in knowledge for the future. So do their suppliers. Du Pont announced that $1,300,000 was granted to educational institutions for the 1960-61 year. Largest portion, $580,000, went to help strengthen education for scientists and engineers.

To survey technical writing. A survey to find what management is doing to help technical people communicate better is being made by Technical Writing Improvement Society (TWIS). The survey will try to find why industry is not doing more to help their key professionals — particularly engineers — write better. Results may show if the reasons are financial, lack of instructors, lack of books and other teaching materials, etc.

Whose business? Gulf Oil has agreed, under a Federal Trade Commission consent order, to sell 30% or $35 million worth of properties it acquired in 1956 when it bought Warren Petroleum. Provisions will force Gulf out of the business of acting as a wholesale and retail distributor of liquefied petroleum gas. The order stipulates that none of the properties may be sold to any of the 23 major companies dealing in natural gas liquids. It's hard to see 23 companies as a monopoly.

It's our job. President Eisenhower did not recommend legislation in his budget message to relieve the producer from utility-type regulation. This issue has become another political hot potato. The natural gas industry can do a lot to cool it off. Your cooling fan is facts — facts served with sweet persuasion.

Economic scarecrow. A statistical error in 1958 government records gave the recession a more tragic look than it ever earned. Actual business volume was $4 billion higher than recorded, and dip in total value of goods and services was only $800 million instead of the $2.5 billion publicized. We weren't as far off as the statisticians.

And that's that. Edict of Swiss government: "Neither the construction of any oil pipeline, nor of any petroleum refinery is by any right conceded by federal law. The government has no intention of embarking upon any such enterprise, nor if such a project should encounter difficulties, to help in any way — either directly or indirectly — with federal funds."

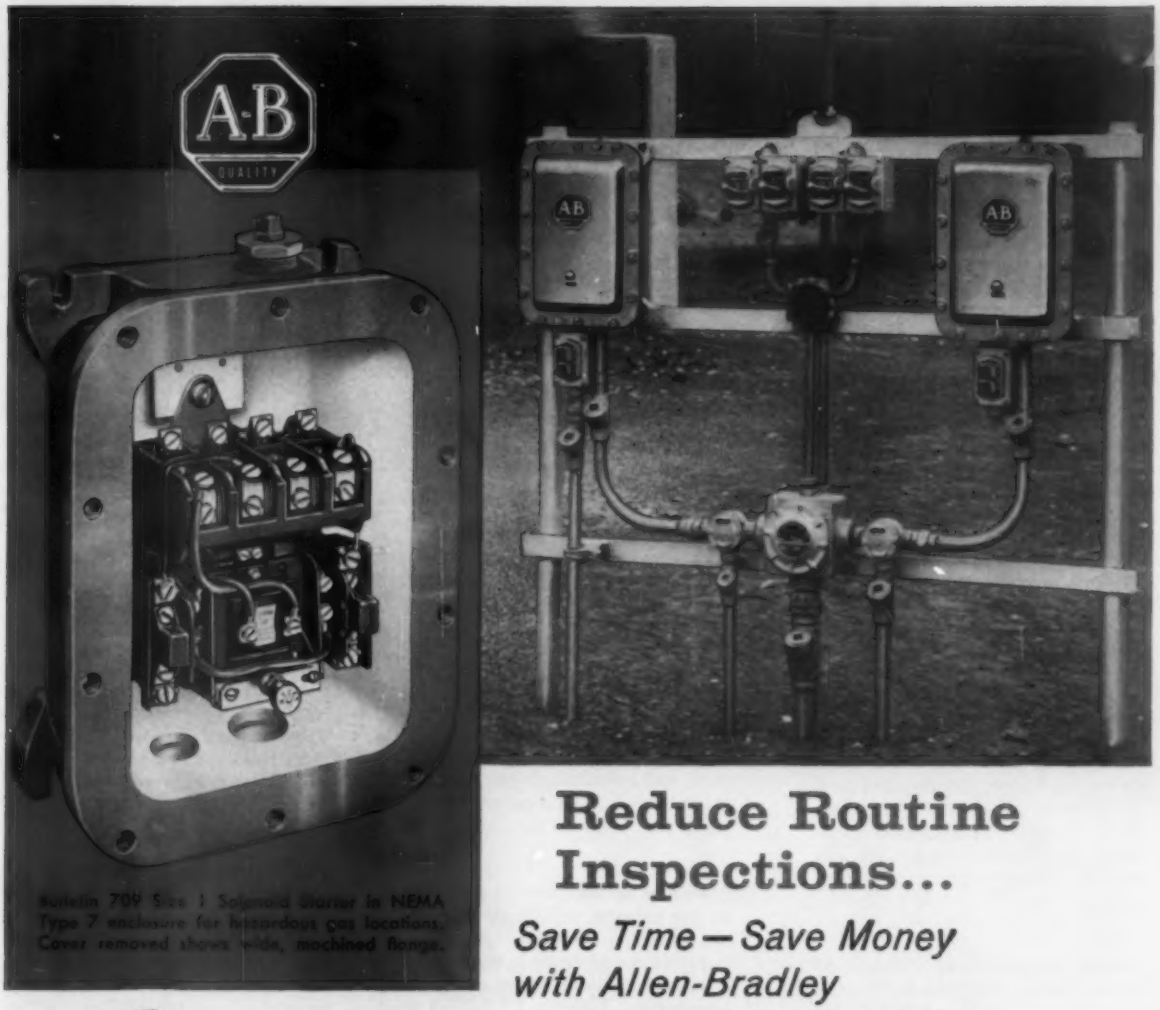
Agreement yet. Empire State Petroleum Association (New York independent distributors) has lined up against the "national fuels policy" proposal advocated by the coal industry. ESPA doesn't always agree with oil producing branch objectives but this looks like one issue that is going to draw the whole diverse crowd in the petroleum industry.

Encouragement. Secretary of Interior Seaton asked again for legislation that would invite private industry to build helium plants. Large quantities are lost in natural gas operations. Demand for helium is increasing and the 5 government plants are only temporarily adequate.

New method, new company. Technique of transporting methane by sea as a liquid at a temperature of 258 F will be developed by a new company. Conoco and Union Stock Yards, which pioneered the research, are joined by Royal Dutch/Shell and Transit Company of Chicago to form Constock International Methane, Ltd. Interests are Conoco 40%, Shell 40%, and the other two 20%.

Social Security in red. In 1959 Social Security program had a deficit of more than $1 billion. Tax went up January 1, which will make income higher than disbursements in 1960. With proposed increases in coverage, Uncle Sam will probably need the red ink again.

Need case processors. Complaints brought in 1952 against several companies for alleged over-charges on certain sales of Middle East oil have been dropped by U. S. Department of Justice. Suit against Caltex was lost in court by government. We'd like to save the money spent on these and other suits (remember Mother Hubbard Case?). Maybe a computer could process complaints — political appointees find it hard.



Bulletin 709 Size 1 Solenoid Starter in NEMA Type 7 enclosure for hazardous gas locations. Cover removed shows wide, machined flange.

Reduce Routine Inspections...

Save Time — Save Money with Allen-Bradley maintenance free starters

The fact that Allen-Bradley motor starters operate over long periods of time—without attention of any kind—is of great value in hazardous locations where inspection requires removing and replacing of bolted enclosures.

A-B solenoid starters have the simplest switching mechanism yet devised. There is only ONE moving part—and this simplicity assures millions of trouble free operations. Also, the double break, silver alloy contacts are always in perfect operating condition—and remain so without attention. The reliable and permanently accurate overload relays protect against motor burnouts, regardless of time or atmospheric conditions. You cannot go wrong when you insist on Allen-Bradley *quality* motor control—especially for your most difficult requirements.

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Corrosive
Gas Locations

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Highlights and footnotes

Whose victory? In the Amoco-OCAW settlement of a 191-day strike at the Texas City refinery, management retained its right to prescribe work in job classifications. The press called this a union-licking, a loss of prestige to OCAW. This viewpoint points up the ridiculous situation we've got into. If the union is managing management, the latter is superfluous. If the union lost face, it was because its face was in the wrong door.

Wants tax hike. President Eisenhower wants added ½¢ Federal tax/gallon on gasoline. He wants to extend the 1¢ tax, scheduled to expire July 1, 1961, to June 30, 1964. Also, he proposes to repeal the recent law earmarking automotive taxes for highways. Altogether, it's enough to ignite a hydrocarbon.

Grace buys. W. R. Grace & Company and Cosden Petroleum have been flirting for several years. Now Grace has bought slightly more than 51 percent of Cosden common stock. Grace owns producing properties and Cosden interests will add refining, petrochemicals and marketing.

Lower estimate. The Bureau of Mines forecast that demand for domestic crude will be 6,890,000 b/d during March, a drop from February forecast of 7,480,000 b/d. B. of M. said refinery runs to stills this month are likely to be much lower than was originally forecast because of high stocks and continued mild weather.

Interest returns. Investment counsellors and mutual funds managements are buying oil stocks again, according to a quarterly survey by A. Wilfred May. They have been lambasted time and again but they do come back after each drop. Income is probably higher on oil shares now than it has been in many years.

Merger planned. Union Oil and Gas of Louisiana and Texas Natural Gasoline have presented merger plans to stockholders. The firm will be called Union Texas Natural Gas Corporation. Richard T. Lyons, Union president, will be president and John T. Oxley, Texas Natural president, will be executive vice president. The merger would make possible an integrated company with Union's producing properties and Texas Natural's plants and marketing facilities.

Who gets what? U. S. News sifted these figures from Department of Commerce data:

OUT OF EACH DOLLAR OF TOTAL INCOME:

	Labor's Share	Government's	Owner's Share
1929	63.5	11.5	25.0
1940	65.2	16.6	18.2
1958	63.7	25.2	11.1

Energy does it. Algerian Industrial Commission has these things planned to use the natural gas from Hassi R'Mel: A liquification plant for gas so it can be shipped to Europe, an ammonia plant, a petrochemical plant, and an electrochemical plant. See Page E-2 for the petroleum industry that began all this.

Double in decade. During the '60's the gas industry will double its sales and more than double its investment in facilities and equipment, reports President Ligon of American Gas Association. Today's $5 billion a year sales revenues will reach $11 billion within 10 years. Investments will increase from $20 to $45 billion.

New relations. U. S. Steel has named Howard Cooper Johnson head of a newly created department — Stockholders Relations. *"This action,"* Chairman Blough said, *"reflects continuing recognition of importance of the stockholders relationship in the overall progress of the corporation."* It looks from here as if relations are getting pretty specialized, too.

Praise be! President Frondizi of Argentina had this to say about American oil concerns who have developed his country's oil: *"The astonishing fact is that these companies, working in reduced areas, will reach in only three years a level of production which it took 40 years for YPF to achieve."*

Suspicion allayed? So weak was the Justice Department's case against 30 oil companies for "conspiracy to raise crude oil prices" during the Suez crisis in 1956 that the suit was dismissed. The defendants didn't even have to present their side. The judge said that *"the evidence doesn't rise above the level of suspicion."* Did you see "Oil Companies Innocent" in a big black headline?

Genius wanted. IPAA is searching through the industry for a man to head the special committee set up to study oil's economic lag. IPAA President Alvin C. Hope said the job will require *"someone challenged by the necessity and possible good results of such a study."*

Rules unchanged. West Coast oil import regulations remain the same. Proposed change to increase ratio of unfinished oil imports was turned down by Secretary of Interior Seaton. Under the proposal each barrel of unfinished oil would count as two barrels of crude oil.

Half as long. Columnist Joseph Alsop states: "In reality, the Soviet 'lead time' from drawing board to production line is commonly only half the American lead time." Wonder why. More engineers? Less static from the front office? Don't tell us brainier engineers.

Baash-Ross acquires Web Wilson. Baash-Ross Division of Joy Manufacturing Company has purchased Web Wilson Oil Tools, Inc., Los Angeles, manufacturer of tongs, elevators and hydra-hooks. The Web Wilson firm will be integrated with the Baash-Ross Division and W. A. "Bill" Wilson, president of Web Wilson, will become a divisional vice president and manager of West Coast operations for Baash-Ross, which manufactures oil and gas well drilling and production tools.

Quick cure. We could pay off the national debt and cover the bills already incurred by Congress if every man, woman, and child in the United States paid $4056. Of course, we'd have to gag our big spenders or we'd soon get elephantine debt again.

Good Wells Make Good News

Engineered Fracturing Treatments That Increased Operators' Profits

March, 1960

The "Frac Guide"* has helped make fracturing more useful than ever before. Here are recent treatments that increased net profits to producers.

- **Wayne County, Illinois** (New Oil Well) A well was completed into the Aux Vases through perforations from 3220 to 3230 feet. Usual practice has been to fracture these wells with one pound 20/40-mesh sand per gallon of fluid. Dowell engineered this treatment with the "Frac Guide": 12,000 gallons gelled crude carrying 20,000 pounds 20/40-mesh sand plus 3000 pounds 10/20-mesh sand. Injection rate was to be 30 bpm and estimated fracture area was 26,000 square feet. Treatment was performed according to recommendations. Before fracturing, well made only a show of oil. After return of load oil, it tested 10 boph.

- **Barber County, Kansas** (Old Oil Well) Completion was open hole into the Mississippi Chat. After the well was deepened to 4612 feet, but before fracturing, the 83-foot open hole section produced 4 to 7 bopd. A fracturing treatment followed recommendations prepared with the "Frac Guide". Treatment was down annulus between 2" tubing and 5½" casing. Frac fluid was 40,000 gallons of water with fluid loss, silicate control and surface tension-reducing agents. 40,000 pounds of sand was used. Injection rate averaged about 35 bpm at 2100 psi maximum pressure. A 200-pound salt plug was used midway in the treatment. The well cleaned up without swabbing and leveled off at 40 bopd flowing.

- **Marion County, East Texas** (Old Oil Well) In 23 months, production had declined from 40 to 13 bopd. Original completion was through perforations into the Henderson formation from 5911 to 5921 feet. Dowell recommended Petrojel*. Well was fractured down tubing at 4.7 bpm and 5400 psi maximum. 12,000 gallons of gelled crude carried 6000 pounds sand. Sand was shut off for two minutes out of every six to reduce danger of blocking perforations. After treatment, production leveled off at 66 bopd — a net increase of 53 bopd.

- **Jefferson County, Oklahoma** (Old Oil Well) Pay zone is the Des Moines sand, and perforations are from 1137 to 1147, 1152 to 1170, and 1364 to 1382 feet. Production had declined to 8 bopd. Well was given a treatment engineered with the "Frac Guide": 15,000 gallons lease oil with F.L.A.* (Fluid Loss Additive) and 30,000 pounds 20/40-mesh sand. 90 ball sealers were used during injection down casing at 26 bpm and 600 psi. After clean-up, well tested 250 bopd — about double the increase normally achieved in this field.

If you want the best possible return per dollar invested in well stimulation, ask Dowell to engineer your frac treatments with the "Frac Guide". For service or detailed information, contact the Dowell office or station nearest you. There are more than 150 locations in the United States, Canada, Venezuela and Argentina. Dowell, Tulsa 1, Oklahoma.

*Dowell Trademark

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by oil men who have used all kinds of gauges

The ten-gallon hat on the Marsh Mastergauge is worn as a crown of acceptance, an emblem of excellence... well earned through years of rugged oil country service.

Just as kings ascend thrones through lineage, the Mastergauge was destined for "royal" acclaim the day it hit the drafting board. Because every product born at Marsh is "born to the purple."

For what other gauge has the Marsh heritage of functional design innovations? Only Marsh offers Conoweld construction, the Marshalloy case, "coined" sector Mastergauge movement, "Recalibrator" adjustment, and optional Safecase protection plus.

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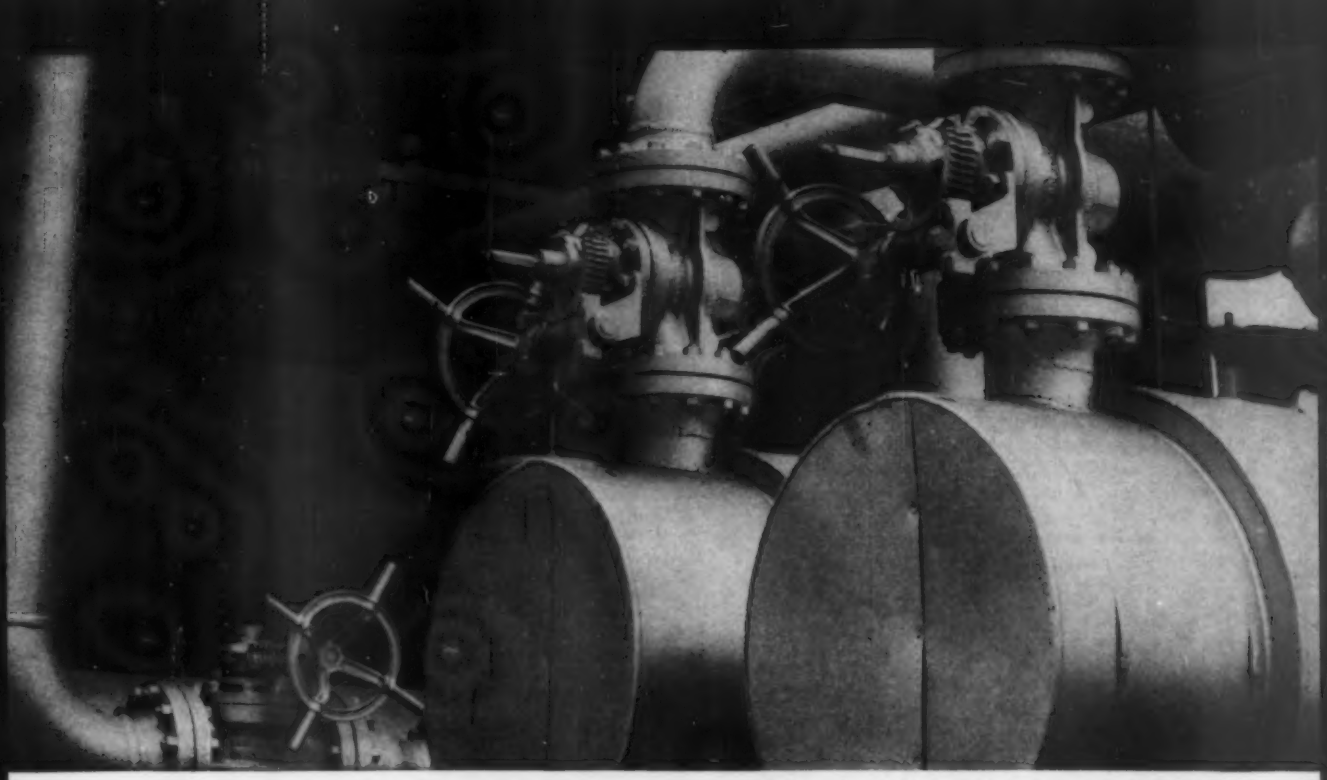

K-51 (Penton) coated Rockwell-Nordstrom valves resist attack by a wide range of corrosive refining fluids.

SPECIAL COATINGS CUT VALVE COSTS

Now, Rockwell-Nordstrom lubricated plug valves are available with special coatings to solve a wide number of corrosion problems that used to require costly special alloy valves.

K-51 (Penton) plastic coatings give iron or steel Rockwell-Nordstrom valves an exceptional corrosion resistance against attack by most acids, caustics and organic-inorganic solvents . . . Kanigen (metallic nickel) coatings assure the corrosion resistance of nickel or stainless steel . . . and Teflon coated plugs assist lubricant efficiency on services where inadequate or infrequent lubrication is anticipated. Whatever your valve needs, for the most difficult services or the easiest ones, the *complete* line of Rockwell-Nordstrom lubricated plug valves can fill your needs better and at lower cost. Write for complete details: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited. Rockwell International S.A., Geneva, Switzerland.

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ROCKWELL-Nordstrom VALVES
another fine product by
ROCKWELL

At tank farms, Rockwell-Nordstrom valves with Teflon coated plugs insure longer performance and instant operation at points remotely located from plant.

THE CONFERENCE TABLE

"A sound human being takes on a responsibility commensurate with his powers."

Still in Forefront

Oil stocks have had their run on the market perhaps, but they continue to be a good investment. Sam Shulsky writes in the Chicago American "Petroleum — now in the discouraging position of world over supply (not an unknown situation for this cyclical industry) — must remain in the forefront of basic industries for its dominant position as a fuel as well as for its source of building blocks for chemistry."

He also advises stockholders who wish to invest during the 60's that "Chemistry must be another growth field."

Union Dues

The AFL-CIO reports that the typical union member pays an initiation fee of $7.50 when he joins, and pays $3.50 a month in dues thereafter. A survey of affiliated unions shows that initiation fees range from a low of less than $5 to a high of $250, the latter figure in effect in two unions. Twelve unions reported dues averaging more than $6 a month. One went to $14 a month, including payments into pension and insurance funds. Four unions said they collect from 1 to 2 percent of the members' monthly earnings as dues.

What Presidents Need

American Management Association quizzed 335 company presidents to see what courses they took in school they now used most in their jobs. The result showed the most votes for:

Economics	43
English	39
Mathematics	24
Engineering	24
Psychology	20
Accounting	17

Have you thought about what courses you use most? Do you have some you should dig into more? You don't have to stop taking courses just because you are working.

Book Describes Oil Economics

This booklet was printed under the auspices of Standard Oil Company (Indiana) as a contribution to a better understanding of the petroleum industry. It reports a presentation at the University of Wisconsin summer short course on "Economics-in-Action," which is designed to supplement theoretical economics training and "to help college teachers pass on to their students a realistic, up-to-date understanding of the economic processes in America."

The economics of oil production, manufacturing and research, marketing, and product distribution were discussed by representatives of Standard and its affiliate, Pan American Petroleum Corporation. Speakers included R. M. Cash, S. Morris Livingston, R. W. Gerhard, J. T. Zich, E. B. Eriksen, and L. W. Ewing, Jr., all representing Standard; Clute Jensen of Pan American Petroleum; and Willard Wilson of the API. H. H. Hardy of Standard coordinated the project. Prof. John L. Miller is director of the economics program.

Copies are available from Professor Miller, University of Wisconsin, Madison.

. . . The Parable of the Paperclips

Curious to know why so many paper clips were being used, a bank once made a survey to find out *how* they were used. The survey tracked down 100,000 clips.

Out of this, 14,163 were twisted and broken during telephone conversations.

Exactly 19,413 were used as chips for card games.

Precisely 7200 were used as makeshift hooks for women's clothes.

No less than 5434 became toothpicks or ear scratchers.

Some 5308 were used as nail cleaners.

And 3916 became pipe cleaners.

The rest were dropped on the floor, swept up, left lying around in odd desk drawers.

So, it turned out that only one in five served the useful purpose for which it was intended — clipping papers together.

This little story doesn't mean that we should go around hoarding paper clips, or rubber bands, or pencils or what-have-you.

It does point out, though, that a little waste can soon become a big waste, whether it involves paper clips, crude oil or anything else we work with.

No matter what our job might be, we should all declare war on waste.

From Atlantic Producer and Pipeliner.

✔ *It's not so bad if your mind goes blank — if you always remember to turn off the sound.*

Do You Have What It Takes?

In this article for the "How to be a Manager" series, Dr. Carl O. Tongberg (Esso Research and Engineering Company) points out the unhappy results when a man

Get some easy practice in first.

achieves a managerial position without the necessary ability. The man suffers as well as the company. Object lesson is: Be sure you have what it takes — then push ahead. But for your own sake, prepare first.

Say "Engineering" Not Technology

"Scientists make it known, but engineers make it work!" This is the theme of a series of public service advertisements by Engineers Joint Council now appearing in *Editor & Publisher*. The ads are designed to create desirable understanding of engineers and engineering.

Carrying such titles as "Let's Get Clear On What Engineers Do," "Just Who's Firing Those Missiles" and "Say Engineer When You Mean Engineer!", the ads may help news writers and editors present to the public a better picture of the engineer and what he does. Here is how one reads:

SAY ENGINEER, WHEN YOU MEAN ENGINEER

Somehow it's become popular to speak of science and technology — popular, that is, with everyone but engineers.

Engineers are in a partnership with scientists in this great industrial nation of ours — designing its products, constructing its communications, and even producing its missiles.

The U. S. is reaping fruits of a highly developed technology — a vast body of engineering and scientific know-how. And the fellows with that know-how are scientists and engineers.

So when you speak of these fellows — or write of them — call them what they call themselves. Call them engineers.

Two Points Stressed

In a recent study by the Committee for Economic Development two fundamental points were made:

1. As the competitive power of other countries, and their reserves, increase, we are entitled to expect and insist upon progressive dismantling of those barriers to our exports that were justified by the "dollar shortage."
2. We are not immune from the law that a country that inflates more rapidly than others will meet trouble in its foreign trade and payments.

Softener Plus Plug

A payroll envelope stuffer is one of the best ways for a company to sell an employee on an idea. When an employee receives his pay he is more susceptible to being influenced by the company as he realizes that the company is responsible for the job that provides the money in the envelope. *Texas Industry*

✔ *The secret of success is constancy of purpose.*
— Disraeli

Hidden Taxes Hurt

Besides the direct taxes and some indirect excises Charlie Green must pay, there are many hidden taxes that are impossible to ferret out for any one taxpayer. Since taxes are a cost of doing business, the taxes a company pays may be passed along in higher prices. These are the really hidden taxes.

For example, Charlie's new car had a Federal excise tax of $176 (he paid half this year on his two-year installment plan). But that $176 does not include hidden taxes. The Automobile Manufacturers' Association estimates that total hidden and direct taxes represent 24 cents of every dollar paid for a car.

On a $2500 car, the AMA figures total taxes as $592. Some $150 goes for taxes connected with materials, parts and their transportation; $137 for taxes paid by the manufacturer; $182 for excise taxes on the car, its radio, heater and tires; $36 for the dealer's property and other taxes; $73 for state sales tax and the rest for miscellaneous taxes.

There are hidden taxes in every other purchase, too. Without trying to find dollar amounts, Tax Foundation spent some time adding up the number of taxes on various items and found there are at least:

100 taxes on an egg
116 taxes on a man's suit
150 taxes on a woman's hat
151 taxes on a loaf of bread
600 taxes on a house

No one knows Charlie's burden of hidden taxes, but it certainly adds up to a sizable chunk of his remaining income. One rough estimate of all taxes, hidden and direct, for the average $7500 family is $2600.

✔ *Education is the apprenticeship of life . . .* — Willmott

Free Booklet for Authors

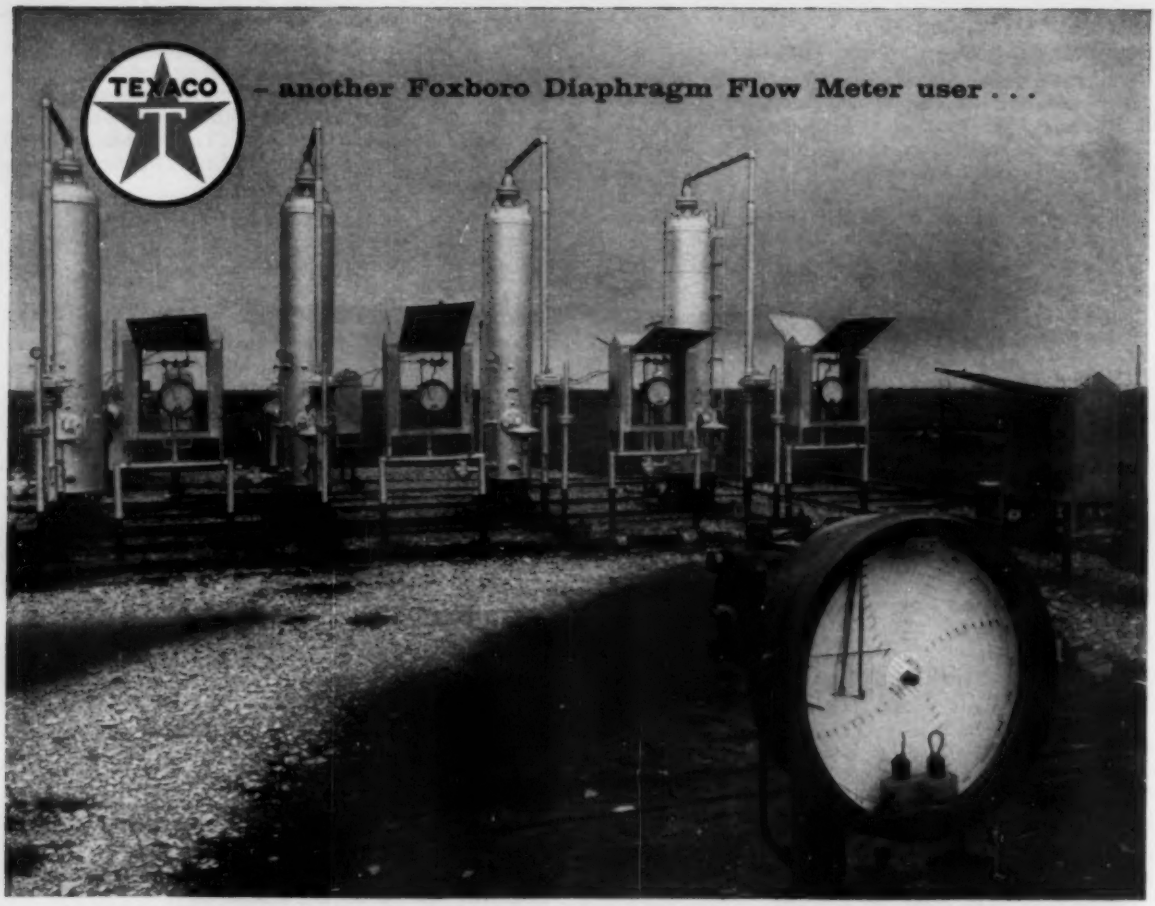
"Anyone who can write a good business letter has all the literary ability he needs to write a good technical or professional book." So begins a new 50-page manual, Writing and Publishing Your Technical Book, just published by F. W. Dodge Corporation, New York book publishers, 119 West 40 Street, New York 18. The book is offered free of charge.

If you have ever contemplated writing a business, professional, or engineering book, you would do well to ask for a copy. The booklet is written to help authors organize and develop their ideas for books to the point where they can obtain the support and backing of a publisher. It answers a great many questions about the author-publisher relationship, and it also presents many practical checklists for preparing material for publication.

The "10 Cannots"

1. You cannot bring about prosperity by discouraging thrift.
2. You cannot help small men by tearing down big men.
3. You cannot strengthen the weak by weakening the strong.
4. You cannot lift the wage earner by pulling down the wage-payer.
5. You cannot help the poor man by destroying the rich.
6. You cannot keep out of trouble by spending more than your income.
7. You cannot further the brotherhood of man by inciting class hatred.
8. You cannot establish security on borrowed money.
9. You cannot build character and courage by taking away man's initiative and independence.
10. You cannot help men permanently by doing for them what they could and should do for themselves.

—Abraham Lincoln



Texaco's Stowell Field, Winnie, Texas — Foxboro Type 37 Diaphragm Meters used on billing service.

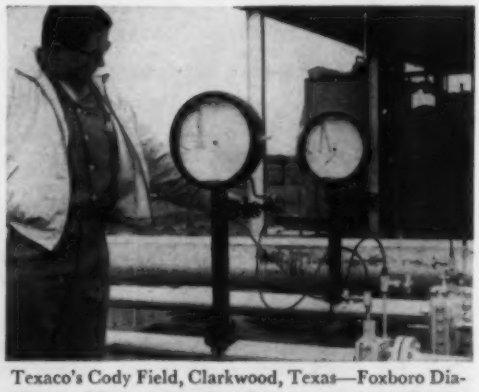
Foxboro Diaphragm Meters eliminate costly mercury maintenance, damage from overrange

There are over 50 Foxboro T/37 Diaphragm Flow Meters in Texaco's East Texas gas fields. Some measure flare gas and gas flow to compressors while others handle billing assignments.

Foxboro Diaphragm Meters give users two distinct benefits. First — since there is no mercury to clean, or replace, they're cheaper to maintain. Second — since the T/37's unique diaphragm assembly can't be damaged by overrange, line surges and winter freeze-ups cease to be a problem.

As for accuracy — monthly checks have found only two of the 50 meters that ever needed recalibration.

Producers, pipeliners, plant men — they're all reporting superior flow metering with Foxboro Diaphragm Flow Meters. Get full details from your nearby Foxboro Field Engineer. Or write for Bulletin 7-15. The Foxboro Company, 383 Norfolk Street, Foxboro, Massachusetts.



Texaco's Cody Field, Clarkwood, Texas—Foxboro Diaphragm Meters measuring flare gas, and gas flow to compressor.

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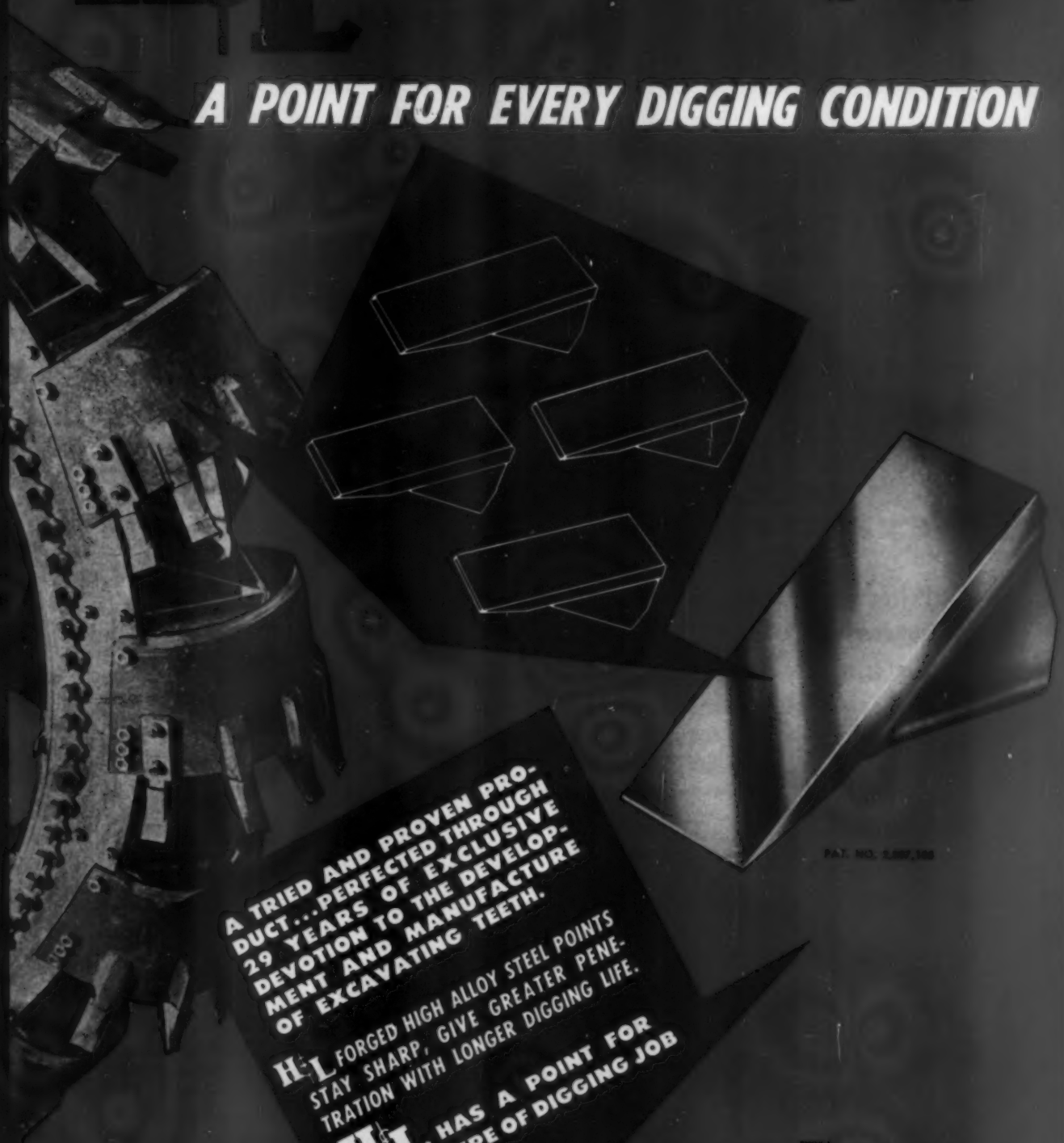

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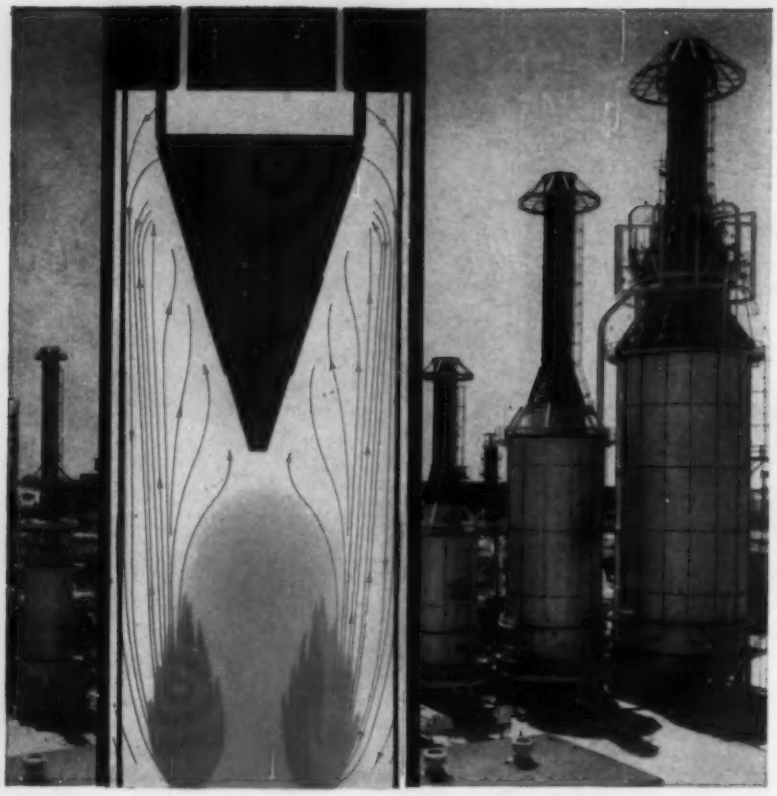

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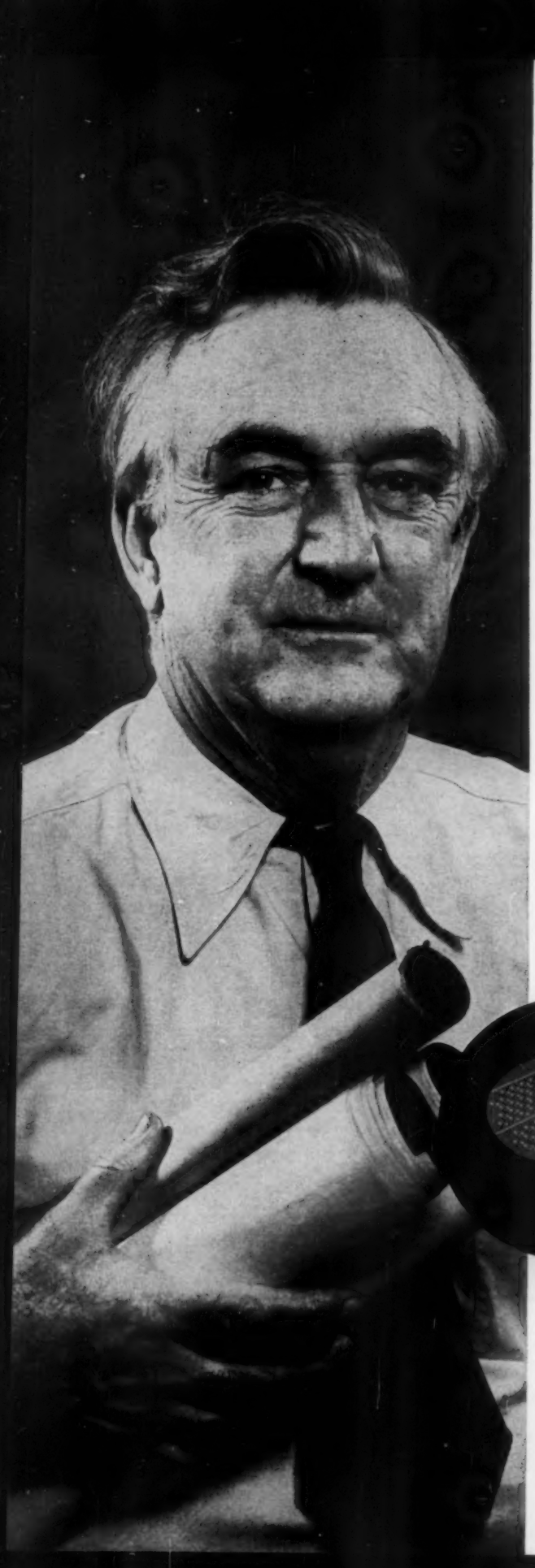

It's who's up front that counts

To the design engineer, "follow-the-leader" sometimes seems to be an industrial pastime.

Imitations always appear on the market to follow a leader – and, when they do, it is best to *choose the leader,* because:

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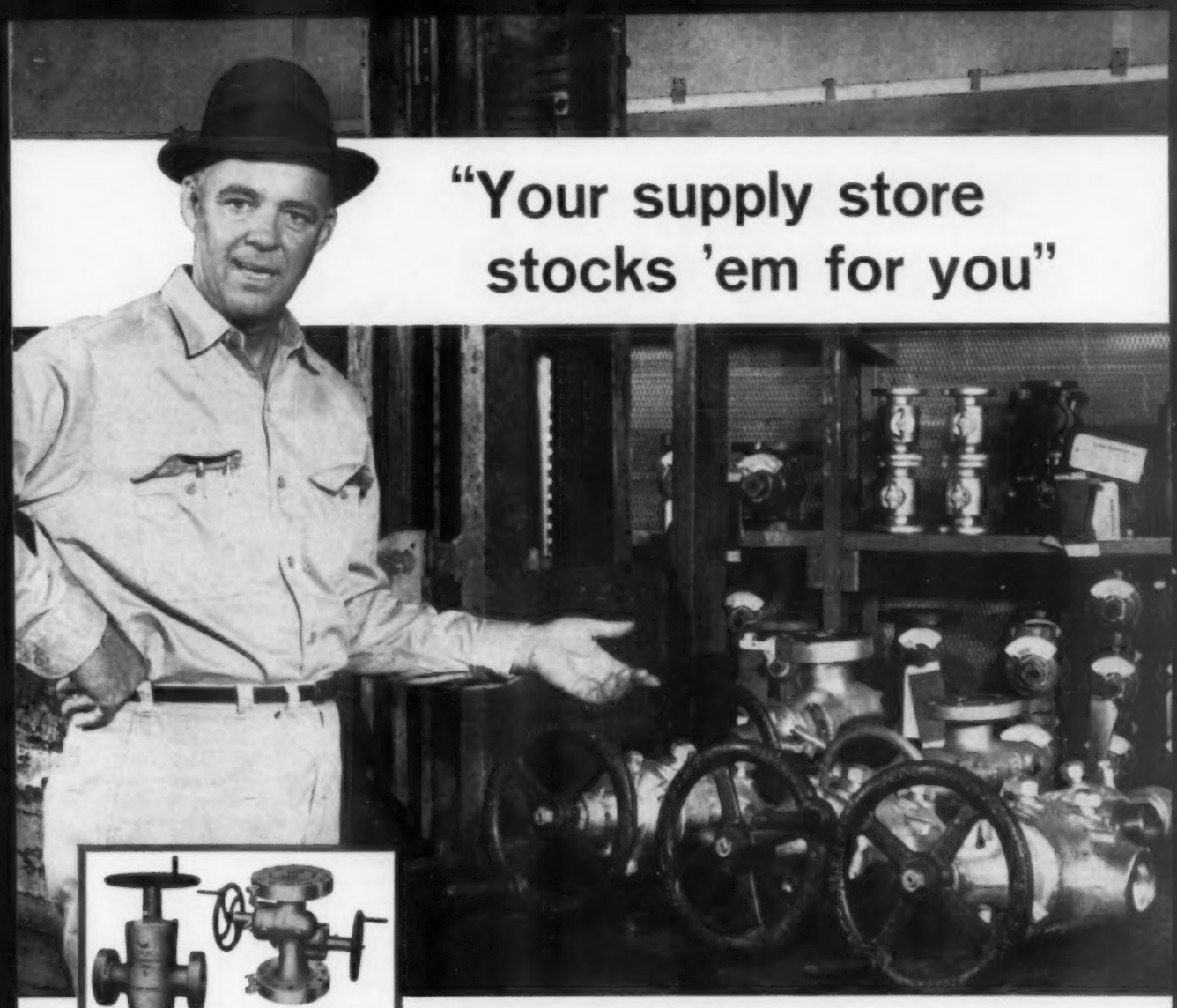

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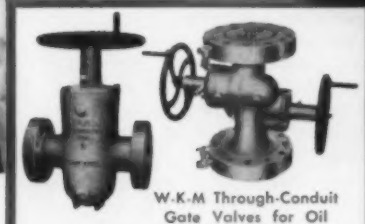

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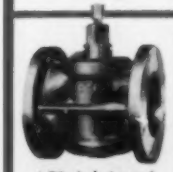

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GLOBAL NOTEBOOK

Algeria--Sahara

French North African area may be one of the world's richest oil and gas prizes . . . In three years one field has discovered an estimated 4-billion barrel reservoir . . . Pipelines are being built to carry the high gravity oil to market . . . Gas lines and refinery are in the engineering stage . . . Petroleum Code sticks to 50-50 division and outside capital is flowing in

Alain Perrodon

IF POLITICIANS would take a siesta, French Algeria and Sahara might easily wake up to find themselves rich enough for once in history to pay their way.

For until oil and gas were found the area's resources were scarcely worth the attention of politicos, although invaders swept the land time and time again.

History*

The history of the land is a history of conquest but no spoils. In the beginning were Berbers, then came the Carthaginian, Roman, Vandal, Byzantine, Arabian, Turkish and French conquests.

The Arabian maneuver may be interesting in view of present times. When the Moors were driven from Spain in 1492 they settled in North Africa and began piracy against Christian nations. To protect themselves from a threatening Spain, they called on Turkey — another Moslem country — to come to their rescue. Turkey sent the famous Barbarossa who set up a military despotism sustained by piracy which lasted down to the French conquest.

For three centuries Algiers was headquarters of the Barbary pirates, who looted shipping and took slaves. The Spanish, French, English and Dutch made fruitless efforts to suppress the traffic. First rebuke was administered in 1803 by Stephen Decatur, commodore of that upstart nation, the United States, which refused to pay tribute to corsairs. (Tripoli declared war on U. S. in 1901.)

The French landed on the Barbary Coast June 14, 1830 and captured Algiers, but France didn't really decide to hold the territory until 10 years later when an army was sent to subdue the nomadic tribes of the interior. In 1848 departments were set up and the area was included in the French customs system.

Alexander Dumas was invited to go to Algeria by the government in 1846 so he could write a book† on his travels to encourage emigration to the area. Subsidized colonists began going into the French territory shortly after that and today there are more than a million Europeans in Algeria. There are also 400,000 Algerians working in France. Agriculture is the biggest industry but food for only 2 or 3 million is produced to feed the 10 million population.

About 9 million people live in the northern territory, an area of 80,117 sq miles which lies along the coast and extends inland about 350 miles. The southern territory, with 967,435 sq miles, extends southward through the Sahara Desert and merges into French West Africa.

Algeria proper has 15 departments; and Sahara two departments — Oases, on the east, and Saoura, on the west.

Situation Today

Turmoil clings to Algeria. The Arabs are divided into several forces, some seeking national independence, some Communists with loyalties in the Red camp, some would hold to traditional French ties. Descendants of early European settlers and recent immigrants are a strong force in favor of Algeria remaining part of France, as it has been for more than an hundred years.

President Charles de Gaulle of the Fifth Republic has offered Algeria self-determination and the Europeans fear they will be ousted by those who may gain control. This offer does not include the Sahara departments, which are governed separately.

Since petroleum is the most important resource and most reserves are in the Sahara, the political dissidence is more inconvenient than hazardous at this time. The future may bring new obstacles, however.

Came Gas and Oil

The French government began geological work in the Sahara about 1948, only three years after the agency, Bureau de Recherches de Petrole (BRP), was established. But before this — in 1927 — a French geologist, Conrad Kilian, returned from an expedition in the desert, announced the Sahara offered great possibilities for oil. Nobody at that time was going to spend the effort to find out.

In the north on the accessible coast the first oil had already been found before Kilian's venture. From about 1914 to 1949 the Tliounet field, in the northwest, had small production. In 1948 SN REPAL (BRP and Algerian government) discovered the Oued Gueterini field, southeast of Algiers. After producing 1,380,000 bbl the field is virtually exhausted. It reached its peak in 1953 when 1748 bbl per day was produced.

The search for oil in the Sahara began in earnest in 1952 when first conces-

*Introduction and parts of article by *The Petroleum Engineer* staff.

†*Adventures in Algeria*, Alexander Dumas (translated by Alma Elizabeth Murch), Chilton Company, Philadelphia.

sions were granted SN REPAL and CFP(A). Other concessions were awarded and the costly work of exploration began over a forbidding, untracked area, which extended as far as a thousand miles from the coast.

Natural gas was found in 1954 and in the fateful year of 1956 explorers hit four jackpots.

In January, after three years work, CREPS (Royal Dutch/Shell 35 percent) discovered the Edjele oil field close to the Libya boundary. The pay was shallow — 1300-1700 ft in Lower Carboniferous sandstone — and tests showed up to 600 bbl per day potential.

Later CREPS also discovered the Tiguentourine field, 44 miles west of Edjele and very similar to it.

The climax of the year was CFPA and SN REPAL discovery of oil at Hassi Messaoud, about 375 miles from the coast and almost the same distance north of Edjele. This field quickly assumed gigantic proportion. Estimates of reserves increase regularly and now are believed to be about 4 billion bbl.

A gas condensate field, Hassi R'Mel, was found by SN REPAL north of Ghardaia.

It was a great year. The next one was slower. New capital was needed. There was a question about the laws and, although France invited partnership capital, the idea of outsiders owning 50 percent of a company was frowned upon.

In 1958 a new oil province was on its way. Twenty-six new concessions were granted and number of companies went from 5 to 24. Five new oil discoveries and 3 gas discoveries were made.

The most significant of the year's events was the new Petroleum Code, based on the 50-50 principle.

Drilling Operations

Fourteen drilling contractors operate in the Sahara, only one with American connections. Camay Drilling Company (subsidiary of Southern California Petroleum Corporation, Los Angeles) is associated with Compagnie Industrielle de Travaux, one of the Schneider Enterprises. Citra-Camay has for 18 months been drilling for CFPA in the Hassi Messaoud area.

Tyler F. Woodward, president of Camay, calls the Sahara "a tremendous oil province." He added, "I do not believe it has been scratched."

He says the French have many well-educated, well-trained engineers in the area who are getting experience on the double-quick.

Drilling conditions are complicated and operations expensive. Majority of wells go over the million-dollar mark in costs.

Two Crude Oil Lines

Of course, oil and gas are no good to anybody until they move to markets. A provisional pipeline and railroad combination allowed Hassi Messaoud field to go on producing early in 1958. Work began on a 24-in. permanent line from the Algerian Port of Bougie, 412 miles to the field and was officially opened the last of 1959. The $105 million needed by SOPEG (subsidiary of CFPA and SN REPAL) was raised partly from the World Bank ($50 million) and debentures.

SOPEG hopes to finish the second stage of the Hassi Messaoud-Bougie pipeline by April 1960 and the third stage by the end of 1960. Each stage represents completion of another pumping station — four are planned.

A second 24-in. crude oil line is beginning its way from the Edjele area, 491 miles across Tunisia to the coast.* CREPS, and its subsidiary TRAPSA, (the pipeline company) have spent some $250 million developing the reservoirs and constructing the pipeline. No income yet.

Marketing Gas Production

Next will come marketing for the vast gas reserves.

The Societe Petroliere de Gerance (SOPEG) (and EGA, an electrical company, 35 percent) plans to begin in April 1960 the 24-in. pipeline to bring natural gas from Hassi R'Mel 327 miles to Algiers and Arzew, east of Oran. Orders for the pipe have been placed and some is already delivered. The line is expected to be finished by

*See "Technical and Manpower Problems Being Encountered in Laying Sahara Pipeline," F. H. Korn, *The Petroleum Engineer*, December 1959, Page D-19.

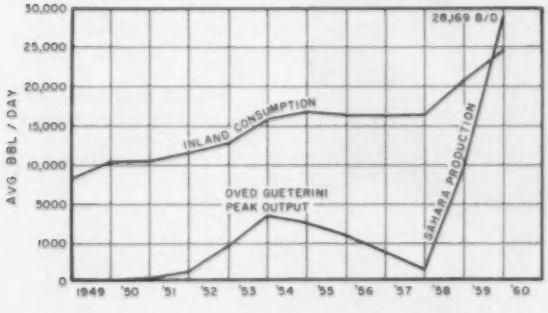
The Author

ALAIN PERRODON was awarded his *licencié es Sciences* in geology by the *Université de Paris*. He spent 1946 at *l'école Nationale Supérieure de Géologie de Nancy;* in 1947 he was awarded *Diplôme d' Ingénieur Géologue by l'Ecole Nationale Supérieure du Petrole.*

He began in 1948 as *ingénieur-géologue* to the *Société Nationale de Recherche et d'Exploitation du Petrole en Algérie* (S. N. REPAL). Dr. Perrodon took a part in many different land-missions in the Chelif's Neogen basin, in the Saharian Atlas and in Sahara. Appointed chief of the Saharian zone in 1954, he next became assistant of the chief geologist, M. Ortynski.

In 1959 Dr. Perrodon became associated with the *Bureau de Recherches de Pétrole*, in Paris, as assistant to the agency's chief geologist.

His doctor's thesis, on the "Sublittoral Neogen Basins of Occidental Algeria" is considered an important reference on the area. He is a lecturer on petroleum geology at the *University de Paris* and at *l'école Nationale Supérieure de Géologie de Nancy*.

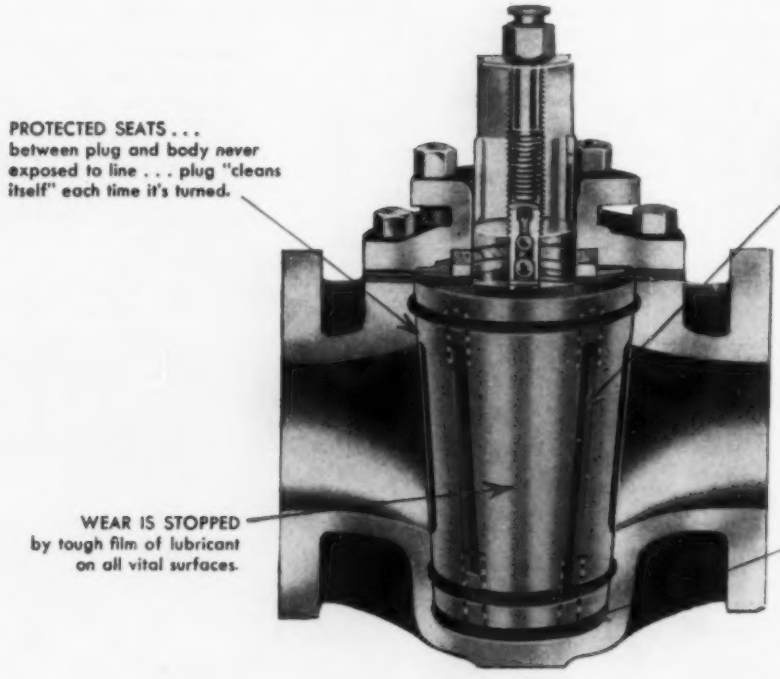


ALGERIA/SAHARA oil output passed consumption for first time in 1959.

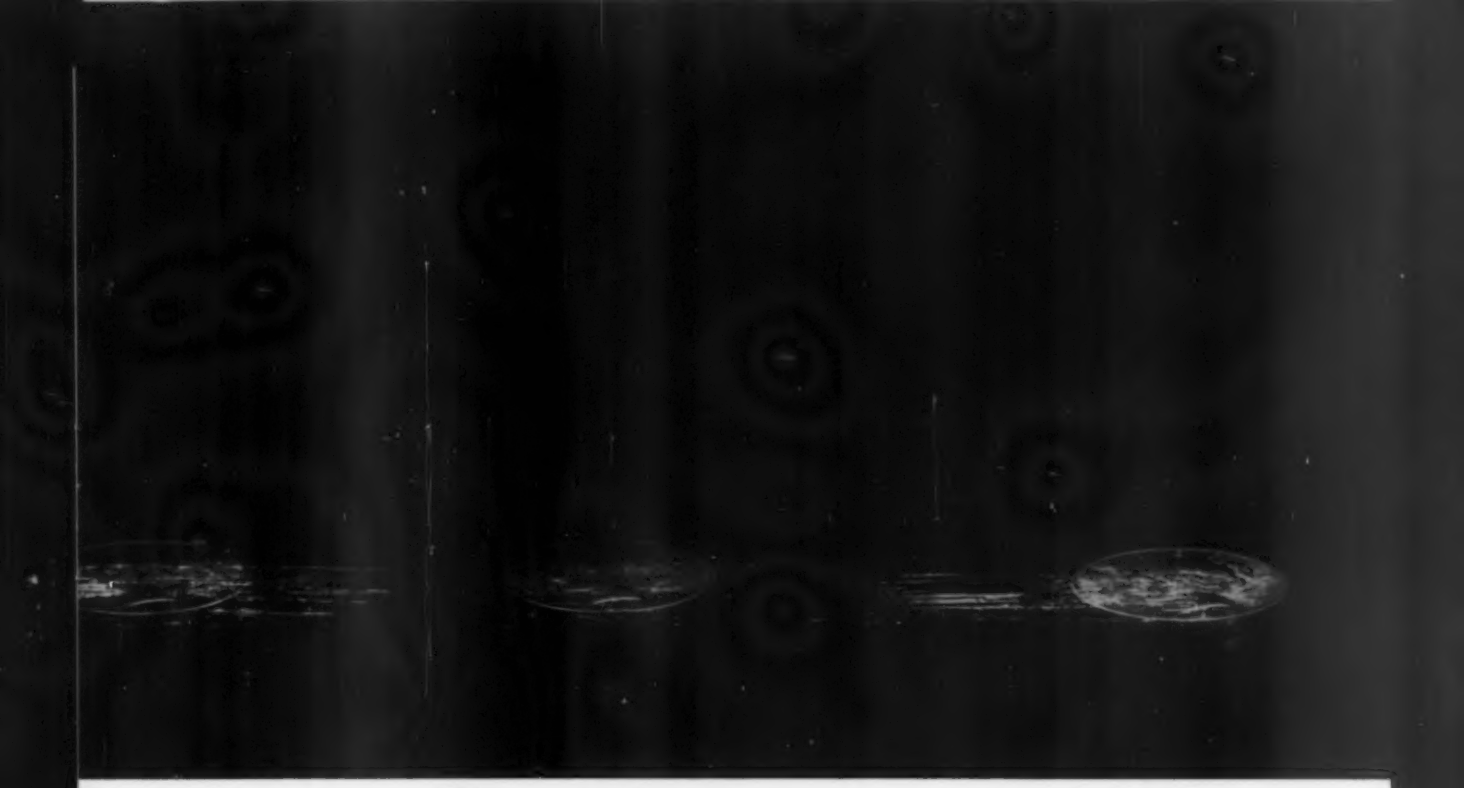
TABLE 1. PARTY MONTHS OF GEOLOGICAL AND GEOPHYSICAL EXPLORATION.

Year	Surface	Seismograph	Gravity	Ground Magnetometer	Air Magnetometer	Electric Telluric	Structural Drilling
1959		251	27		11		
1958	57	221	17	4	0		12
1957	42	161	44	0	13		20
1956	52	129	51	0	11	12	15
1955	151	84	71	31	3	6	10
1954	217	68	46	18		7	31
1953	265	41	39	12		0	10
1952		30	15	3		10	0
1951		24	10	0		12	0
1950		12	18	0		8	0

Make valve dollars go


PROTECTED SEATS . . . between plug and body never exposed to line . . . plug "cleans itself" each time it's turned.
LEAKPROOF operation assured by pressurized lubricant seals between plug and body.
WEAR IS STOPPED by tough film of lubricant on all vital surfaces.
CAN'T GALL because lubricant hydraulically "jacks" plug keeping it free for instant operation.

Lubrication makes the



farther with

LUBRICONOMY

"Lubriconomy" is a streamlined way of saying that valve lubrication *is* economy . . . it saves money by eliminating wear.

Lubrication in Rockwell-Nordstrom valves will make your valve dollars go farther because it eliminates the wear of metal-to-metal friction on *every* moving part. Comparing these valves to other types is simply comparing a lubricated to a non-lubricated mechanism . . . which would you expect to work better, longer and at lower cost?

But lubrication in Rockwell-Nordstrom valves does more than eliminate wear—it assures extraordinary leak-proof control and dependability. *Pressurized* lubricant in the exclusive Sealdport® system creates a powerful double seal against leakage. (Much like a puncture-proof tire, pressurized lubricant sealing "heals itself" if cut, scratched or worn). And lubricant also hydraulically cushions the plug to keep it free for *instant*, quarter-turn operation.

More than 6 *million* Rockwell-Nordstrom valves are saving money today on every imaginable type of service. Why don't you try just one where you've had valve problems? Write for details, or have a Rockwell field engineer visit you. Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

difference

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL

Concessions Shown on Map Opposite

SAHARA — PERMITS GRANTED

Number	Block Name	Company	Area, sq. km.*	Date of Expiration
S 1	Oued Namous	C.F.P. (A)	9,800	24 Oct. 62
S 2 A	Oued el Rharbi O.	S.N. REPAL	1,200	24 Mar. 63
S 2 B	Oned el Rharbi E.	"	10,800	"
S 3 A	Erg el Anngueur O.	C.F.P. (A)	3,300	24 Jan. 63
S 3 B	Erg el Anngueur N.	"	2,500	"
S 3 C	Erg el Anngueur E.	"	3,800	"
S 4 A	Berriane Ouest	S.N. REPAL	9,600	"
S 4 B	Berriane Est	"	800	"
S 5	Laghouat	C.F.P. (A)	8,000	"
S 6 A	El Guettar	S.N. REPAL	4,610	24 Mar. 63
S 6 B	Erg Tefelet	"	2,320	"
S 7 A	Djamaa Ouest	C.F.P. (A)	5,800	24 Jan. 63
S 7 B	Djamaa Est	"	2,200	"
S 8 A	El Oued Touggourt O.	S.N. REPAL	600	24 Oct. 62
S 8 B	El Oued Touggourt E.	"	9,800	"
S 9 A	Ouargla Ouest	C.F.P. (A)	3,000	"
S 9 B	Ouargla Est	"	8,200	"
S 10 A	Oued Fahl Ouest	S.N. REPAL	7,400	"
S 10 B	Oued Fahl Est	"	600	"
S 11 A	El Golea N.-O	C.F.P. (A)	900	"
S 11 B	El Golea Est	"	7,200	"
S 12	Oued Mya	S.N. REPAL	8,800	"
S 13	Timimoun	C.P.A.	11,550	29 Sept. 63
S 14 A	Fort Mac Mahon N.	"	138	29 July 63
S 14 B	Fort Mac Mahon O.	"	10,825	"
S 15 A	In Belbel Ouest	"	6,733	29 May 63
S 15 B	In Belbel Est	"	5,172	"
S 16 A	Tademait Ouest	"	2,398	"
S 16 B	Tademait Nord	"	875	"
S 16 C	Tademait Est	"	7,552	"
S 17	Hassi Inifel	"	11,419	"
S 18	Hassi M'Segguem	"	11,804	"
S 19 A	Hassi el Biod Nord	"	10,261	29 July 63
S 19 B	Hassi el Biod Est	"	337	"
S 19 C	Hassi el Biod Sud	"	384	"
S 20 A	Aoulef Ouest	C.R.E.P.S.	1,985	29 May 63
S 20 B	Aoulef Nord	"	335	"
S 20 C	Aoulef Est	"	8,661	"
S 21 A	In Salah Nord	"	5,486	"
S 21 B	In Salah Sud	"	6,450	"
S 22	Djebel el Beida	"	12,529	"
S 23	Djebel Idjerane	"	19,100	Abandoned
S 24 A	Isaouane Nord	"	5,122	29 May 63
S 24 B	Isaouane Sud	"	1,618	"
S 25 A	Tadientourt Ouest	"	595	"
S 25 B	Tadientourt Nord	"	6,829	"
S 26	Zarzaitine	"	7,574	"
S 27 A	Fort Miribel O.	C.F.P. (A)	1,270	7 Oct. 63
S 27 B	Fort Miribel E.	"	2,730	"
S 28	Oued Saret	S.N. REPAL	3,900	"
S 29	Colomb-Bechar	"	43,200	5 Mar. 60
S 30	Agueiba	C.R.E.P.S.	9,868	19 June 61
S 31	Azzel Matti	"	9,868	"
S 32	Takouazet	"	6,000	30 Mar. 62
S 33	Irharhar	C.P.A.	5,200	"
S 34	Hassi Tabankort	C.E.P.	11,200	"
S 35	Temejide	"	6,400	"
S 36	Timellouline	C.E.P.	5,950	30 May 62
S 37	Hassi Imoulaye	"	9,740	30 Nov. 62
S 38	Bir Ben Takoui	"	21,450	28 Aug. 62
S 39	El Mouilek	"	20,700	28 July 63
S 40	Hassi Ambrosini	"	14,475	"
S 41	Reggan	"	13,700	28 Dec. 62
S 42	Moulah	"	13,500	28 Aug. 62
S 43 A	Bou Krenissa	S.N.P.A.	2,500	22 Mar. 63
S 43 B	El Baroud	"	3,500	"
S 43 C	Hassi el Gassi	"	2,000	"
S 44	Oued N'Sa	S.P.V.	4,600	"
S 45 A	Hassi Melah	PREPA FRANCAREP AFROPEC	2,600	"
S 45 B	Hassi el Hadjar	"	1,500	"
S 45 C	Oulougga	"	2,300	"
S 46	El Hobra	C.R.E.P.S.	2,700	"
S 47 A	Oued Metilli	C.P.A.	1,500	"
S 47 B	Hassi Keskes	"	1,200	"
S 48	Era Foukani	PETROSAREP	1,200	"
S 49 A	El Morr	COPEFA-OMNI-REX-PHILLIPS	1,300	"
S 49 B	Hassi Touareg	"	2,000	"
S 50 A	El Fakir	SAFREP,	2,400	18 May 63
S 50 B	Daiet Remt	SAFREP	1,800	18 May 63
S 50 C	Ben Mouley	"	300	"
S 50 D	Guemar	"	300	"
S 50 E	Mouiet er Rebah	"	200	"
S 51	El Aziba	S.N.REPAL	3,300	20 May 63
S 52	Dorbane	C.F.P. (A)	6,500	"
S 53	Oued Mehaiguene	"	4,000	"
S 54	Tindouf	SAFREP	69,600	18 Aug. 63
S 55	Djorf et Atfal	S.P.V.	3,100	29 Aug. 63
S 56 A	Hassi Menkel	"	8,000	28 Sept. 63
S 56 B	El Hassine	"	1,800	"
S 57 A	Bordj Nili	SAFREP	5,800	"
S 57 B	Rhamra	"	800	"
S 58	El Meharis	PETROSAREP	2,700	"
S 59 A	Bou Aicha	PREPA-FRANCAREP-	3,000	"
S 59 B	Megarine	AFROPEC	1,100	"
S 60	El Atchane	COPEFA-OMNI-REX PHILLIPS	7,075	"
S 61	Daiet el Habs	PETROPAR-FRANCAREP-FRANDEL	1,800	"
S 62	Hassi Nador	PETROPAR-F.I.P.-C.F.I.M.	2,700	"
S 63	Tarfaia	C.P.A.	6,300	"
S 64	Beressof	COPEFA	5,800	"
S 65 A	Cottenest	S.N. REPAL-FRANCA-REPEURAFREP	910	"
S 65 B	Erg Tangousman	"	1,215	"
S 66	Tihigaline	C.F.P. (A)	3,800	"
S 67	Taouratine	PETROPAR-A.M.I.F.	1,900	"
S 68	Erg Bourharet	SAFREP	900	"
S 69	Erg el Agreb	S.N.P.A.	4,400	1 Apr. 64
S 70	Hassi Leila	PETROPAR-A.M.I.F.	5,800	"
S 71	Hassi Chaambi	COPEFA-OMNI-REX-PHILLIPS	600	7 Mar. 64
S 72	El Medarba	COPAREX	1,800	18 June 64
S 73	Erg Oriental	C.F.P. (A)-PETROPAR-ESSO	20,600	3 July 64
S 74 A	Sekaifaf	FRANCAREP	453	18 June 62
S 74 B	Hassi Farida	"	452	"
S 75	Tan Emellel	EURAFREP	625	"
S 111A	Krobna	PREPA-FRANCAREP-	1,700	21 Jan. 65
S 111B	Hassi Berkane	AFROFEC	3,800	"
S 111C	Gueddich	"	1,600	"
S 116	Erg Barga	S.P.V.	1,200	22 Mar. 63

*1 sq. km. = 0.384 sq. mi.

SAHARA — PERMITS REQUESTED

Number	Block Name	Company	Area	Dates
S 104	Hassi Tartrat	C.P.A.	671	23 Sept. 57
S 110	Rhourde Hamra	PETROPAR-FRANCAREP-FRANDEL	7,160	7 May 58
S 112	Lejamate	C.P.A.†	15,000	19 July 58
S 117	Loudje	"	770	20 Oct. 58
S 120				
S 121		"		
S 126		"		
S 127	Merouane	CFIM, FIP†	1,600	8 Apr. 59
S 128				
S 129	H'Mamoura	SPV*	2,100	5 Oct. 59

†Other interests involved.

ALGERIA — PERMITS GRANTED

Hodna	S.N. REPAL	9,270	17 Nov. 61
Constantine	"	5,414	"
Tebessa	"	16,845	"
Ouled Djellal O.	"	890	24 Mar. 63
Ouled Djellal E.	"	180	"
Sidi Aissa	CAREP	2,975	"

ALGERIA — PERMITS REQUESTED

Taria-Charrier	CAREP	16,076	16 June 58
Bir Rabalou-Aumale	"	3,920	28 June 58
Recheiga-Foucauld	"	6,430	"
Negrine	S.N. REPAL	18,983	10 Nov. 54
Chelif	"	2,460	27 Oct. 58
Djebel Bou Daoud	PREPA, FRANCAREP,	2,480	30 July 58
Djebel el Azreg	AFROPEC	8,150	"
Chellala Reibel	S.P.H.P.	9,866	24 July 58

ALGERIA-SAHARA

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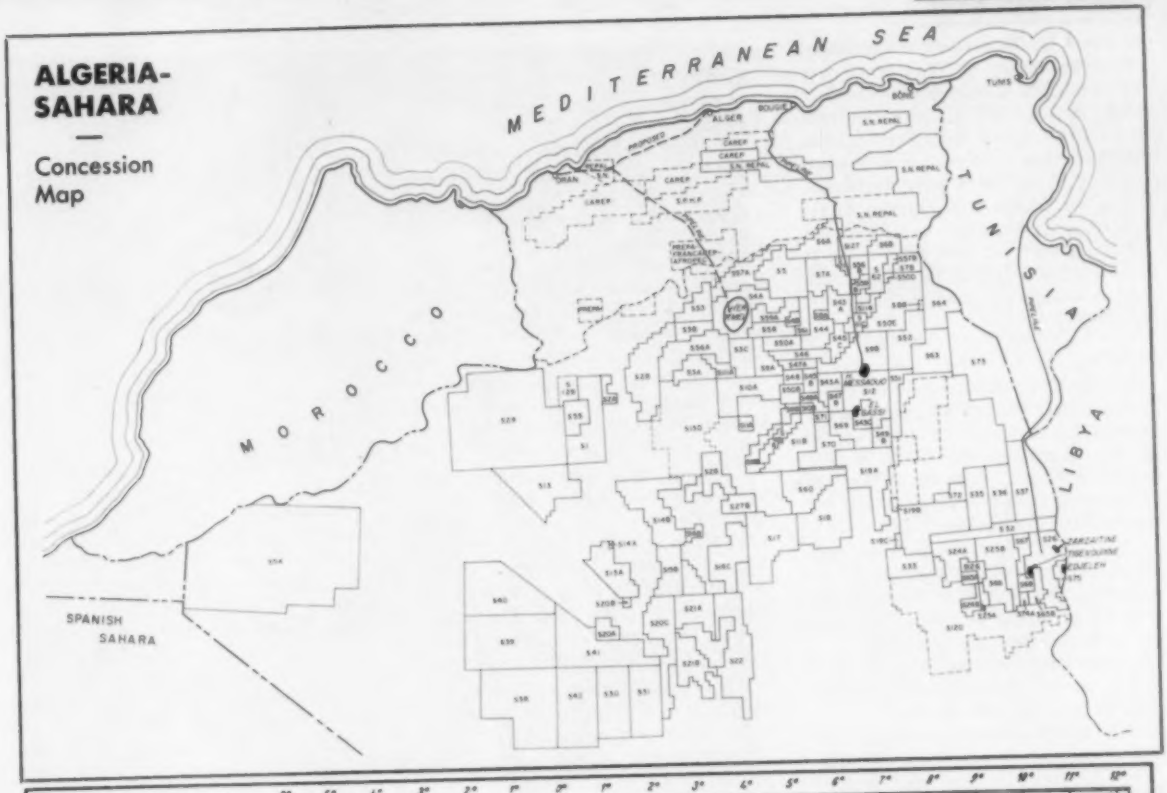
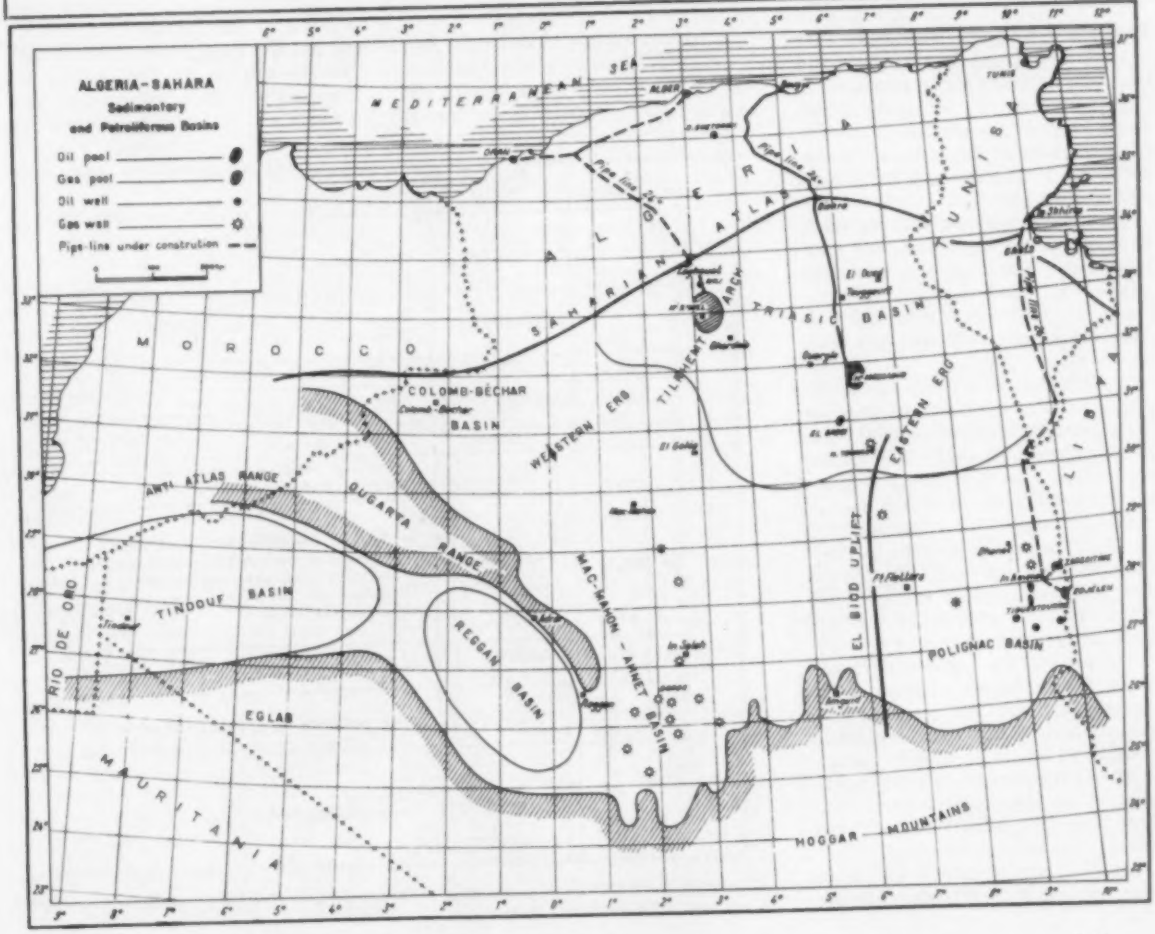
Concession Map





the end of 1960 at a cost of $41 million.

Under study by du Transport Intercontinental du Gaz Naturel (INTERGAZ) is a natural gas pipeline from North Africa via Gibraltar or the Mediterranean to Spain and France. This 1750-mile, 36-in. pipeline via Gibraltar to Strasbourg, France, would cost an estimated $500 million for an initial delivery of 600 million cu ft daily and $650 million for an ultimate single line delivery of one billion cubic feet daily.

Refining

The good quality crude might find more outlets if it were processed on the coast and a company has been set up for this purpose. Participants of Societe de la Raffinerie d'Alger are CFP, 23.8 percent; CFR, 14 percent; Shell, 21 percent; BP, 12 percent; Jersey, 16.2 percent; Beryl Algerie, 7 percent; Mobil, 6 percent. It is expected to be completed next year with an initial capacity of 50,000 bbl per day. Plans are to double this capacity later.

France itself requires large volumes of fuel oil, for which Middle East production is more suitable but markets must be found and the expanding economy of Europe provides good potential.

The Land and its Geology

Let's take a look at this disturbing land that so firmly hid its riches.

Fertile plains lie along the coast, about 50 miles broad. From these rise a border chain of the Atlas mountains, called the Tellian Atlas. This northern zone is called the Tell.

The central zone includes the south slope of this range and Saharian Atlas Mountains. There are a few streams and saline lakes between the two ranges. On the south side the Saharian Atlas chain breaks off sharply toward the desert.

The third zone is the immense Algerian Sahara, 1,000,000 sq miles of vast expanse, nearly four times as big as Texas with perhaps only a half million population. They are mostly Berbers, the original inhabitants of Algeria.

Search for geologic information on the North Sahara took shape in 1948, although it was not until 1951 that the first reflection seismic surveys were started. This was preceded by a general gravimetric reconnaisance. It was difficult to separate the signal of reflection waves from the noise level of weathered surface beds. And the existence of a thick secondary formation comprising several calcareous layers, evaporite beds and a considerable salt-bearing element all but absorbed reflections from underlying beds. So, in 1952, refraction seismic tests were commenced.

Much of the structural conditions were delineated by refraction seismograph and correlated with actual drilling. The survey finally covered the entire areas granted to SN REPAL — CFP(A).

The first tectonic map was drawn up as early as the summer of 1954. By 1958, the joint effort by CFT(A) and SN REPAL in their Northern Saharian concessions revealed the existence of Paleozoic and Mesozoic sedimentary basins, completely masked by recent deposits. The western region is characterized by a Siluro-Devonian basin. Secondary basins with an important salt series cover the eastern region. Between these two, a high central region seems to have remained stable throughout the primary and secondary.

The paleogeographical outline map of these different basins brings out two important structural trends on which are situated Hassi er R'mel and Hassi Messaoud fields. The former corresponds with the Tilrhemt arch which occupies the highest part of the central region. It is a pinch-out in the Triassic sand reservoir, resting on a large dome.

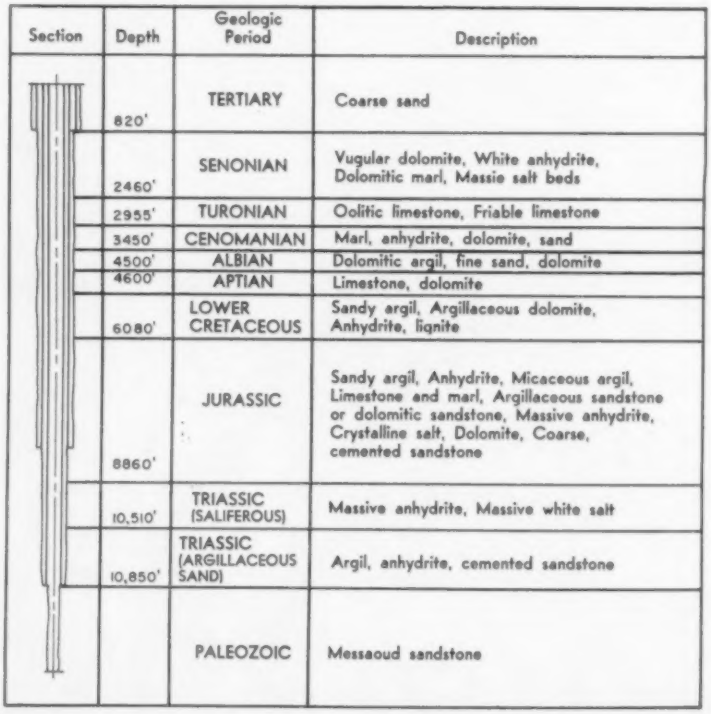
The Hassi Messaoud reservoir is a very flat anticline in the Cambro-Ordovician sandstone which is evident in the sedimentary features up to the beginning of the Upper Cretaceous.

In both cases, the unconformity separating the Primary and the Secondary has played an important part in the reservoir makeup either by the formation of transgressive detrial beds or by the amelioration of the reservoir characteristics of the sandstone by the pre-Triassic erosion. In both fields, a thick triassic salt series provides an excellent caprock.

TABLE 2. EXPLORATION EMPLOYMENT AND COSTS.

	Men employed	Cost of exploration Francs (billions)	Dollars
1953	2077	3.1	$ 6,279,000
1954	2413	9.1	18,432,000
1955	2972	9.7	19,648,000
1956	4085	14.7	29,775,000
1957	4874	25.0	50,638,000
1958	5400	50.0	101,276,000
1959	7500	43.5	87,080,000
1960		53.4	107,000,000

Results of exploration in the last 10 years reveal huge geologic features marked on the surface by vast horizontal formations of recent age. A certain number of basins also have been outlined. The Sahara was covered extensively by Paleozoic seas which deposited fairly homogeneous and regular formations, proceeding from the Cambrian to the Upper Carboniferous. In the midst of this immense domain, the sedimentary basins barely resemble the layout after the Carboniferous, following the first movements of the Hercynien orogenesis. At the end of the Carboniferous the massive ranges were lifted, such as the Hoggar, and the



STRATIGRAPHIC COLUMN in the Hassi Messaoud field showing typical casing setting depths in relation to the geologic column.

MASTS TOWER above the desert floor of French Sahara in their search for oil.
— Photo courtesy Phillips Petroleum Company.

folded chains, such as the Ougarta mountains, formed several tectonic basins. Map on page E-7 shows these basins.

1. Tindouf and Reggan basins . . . to the west, between the Eglab Arch and the folded chains of the Anti-Atlas and the Ougarta.

2. Colomb-Bechar and Mac Mahon-Ahnet basins, between the Ougarta and the Tilrempt Arch.

3. Fort Polignac basin, to the east of El Biod uplift.

At the inception of the Hercynienne orogenesis the Sahara domain was completely tilted, displacing the zones of subsidence from west to east, the Mesozoic oceans advancing from the northeast beginning in Southern Tunisia. This resulted in the formation of a secondary sedimentary basin in the northeast (which was previously stable) during the Paleozoic and extension of the saliferous Triassic formations known as the Province of the North, or the Triassic basin.

Work during the last few years has permitted a clear definition of a gas-producing region, corresponding to the Ahnet and the Mac-Mahon basins, and two petroleum regions of Fort Polignac and of the Northeast.

1. *Mac Mahon Ahnet Province*

Gas was first discovered in the Sahara at Djebel Berga in 1954. Since that time a dozen other dry gas reservoirs have been discovered in the province, principally in the Devonian and Cambro-Ordivician. Traps are of these traps are formed by regional anticlines. Recoverable reserves from these different fields are estimated at 15 billion cubic meters (530 billion cu ft).

2. *Fort Polignac Province*

The first oil discovery of the Sahara was in the Fort Polignac basin on the Edjele structure in January 1956. In the following years other oil fields were found, of which the Tiguentourine and Zarzaitine were the most important.

The reservoirs consist of the sandstone of the Carboniferous, Devonian, and Cambro-Ordivician. Traps are formed by anticlines whose crowns were closed by faults. Recoverable reserves of this province are presently estimated at about 120 million cubic meters (760 million bbl).

TABLE 3. DRILLING OPERATIONS.

Year	Rigs	Footage
1959	41	1,013,770
1958	36	820,200
1957	27	452,750
1956	19	219,490
1955	15	196,190
1954	16	220,800
1953	7	143,400
1952	8	115,568
1951	4	99,308
1950	4	91,800

3. *Northwest Province of the Triassic Basin*

This province has the two most important reservoirs of oil and gas, Hassi Messaoud and Hassi R'Mel, discovered in 1956. In 1959, a second reservoir of oil was discovered 60 miles south of Messaoud at El Gassi.

Production capacity of Hassi Messaoud will be 200,000 bbl a day at the end of this year, French sources estimate. Oil sands are 10,500 to 12,500 ft deep and are about 450 to 500 ft thick. The one rig on the desert at the first location in 1956 has been transformed into a thriving community.

These accumulations follow two large positive axes trending south, Hassi R'Mel on the Mole de Tilrempt and Hassi Messaoud-El Gassi on the elongation down d'Amguid promontory.

The reservoirs of the Hassi R'Mel consist of Triassic sands overlying the Cambrian. Those of the Hassi Messaoud-El Gassi consist of eroded Cambrian sandstones, covered irregularly by the clays and salt beds of the Triassic. Oil traps consist of large domes, highly tilted, probably complicated by bordering faults.

Recoverable gas reserves of the Hassi R'Mel are estimated at a trillion cubic meters (35.3 trillion cu ft) and the oil reserves of Hassi Messaoud at about 500 million cubic meters (4 billion bbl).

Petroleum Laws - Taxes

The many-initialed companies who ventured into the desert and spent millions of dollars (or more appro-

TABLE 4. DRILLING CONTRACTORS IN SAHARA.
(November 1959)

	Rigs		
	Heavy	Medium	Light
CITRA-CAMAY	2	—	—
COFOR	1	—	—
COMAFOR	—	1	—
EFNA	1	—	—
FORAFRANCE	1	1	—
FORASOL	1	1	—
FOREX	1	1	—
FORENCO	4	1	—
INTERFOR	2	—	—
L.T.S.	2	2	1
NORAFOR	1	3	5
S.L.F.P.	5	—	—
SIFOREP	—	2	1
SOGEFOR	1	—	—
	22	12	7
TOTAL			41 rigs

priately, francs) on exploration were responding to the inviting and reasonable laws that govern exploration and exploitation operations.

The French government awarded exclusive prospecting licenses without cost to those with technical and financial capacity. Exploration permits were granted for 3, 4, or 5 years with renewals possible at the end of the first and second period. Required minimum investment varies from block to block between 450 to 2850 million francs ($1.1 to $6.8 million). In November 1958, the Organisation Commune des Regions Sahariennes (OCRS) was approved, based on the principle of 50-50 partition of profits, which is guaranteed for 50 years. It covers conditions for exploration, development and transportation. For exploration permits at each renewal, part of the area held must be surrendered but annual expenditure obligations remain the same. The relinquished areas can be put up for auction.

Royalty for oil is 12½ percent in cash or in kind and for gas 5 percent. An income tax on profits will bring about a 50-50 split (including royalty and any other taxes) between the State and the concessionaire. A deduction on account of depletion may be made from current taxable income of 27½ percent of wellhead value of the oil up to a maximum of 50 percent of net profits, nominally as in the U. S. A. and France.

There is still no mention of the extent of foreign participation in companies operating in the Sahara. Before the new code no concession was granted to any company with more than 49 percent foreign interest. (An exception is Shell's 65 percent interest in CPA. This, however, is balanced by its 35 percent share in CREPS, which has the same French partner.)

Right of the concessionaire to lay pipelines to transport oil or gas is under OCRS jurisdiction. There is a provision that Sahara natural gas must be supplied to Algeria at a preferential rate.

Prospectors have no taxes during exploration except customs on equipment. A modification of the recent French petroleum law provides that companies searching for oil in Algeria and Sahara will not in future have to pay the 6 to 10 percent turnover tax on imported equipment and on service, which is generally chargeable.

Interests In Concessions

U. S. companies are associated with French firms in this venture. Here are those with concessions:

Phillips Petroleum Company has five tracts totaling 4,145,105 acres (net 1,455,852 to Phillips). An exploratory well is being drilled on the Hassi Touarog block (operated by a partner) and seismic work is under way on the Phillips-operated El Atchane block with drilling planned this year.

Cities Service and French interests have 4,400,000 acres under concession in the Hassi Messaoud area. Cities Service has a 49 percent interest and is operator on part of the concession. PREPA, one of its two French associates, operates the remainder. The third company involved is FRANCAREP. Initial test was spudded December 2 and a second one is planned. Cities Service also holds a 15 percent interest in a 20,000 acre tract in Southwest Sahara.

Franco Wyoming, through its French subsidiary, Compagnie Franco Industrielle et Maritime (SARL) has an interest in the Hassi Nador concession of 1042 sq miles. This is held with PETROPAR and the French subsidiary of Pan American International Oil Company (Standard Indiana).

Jersey Standard concluded an agreement with CFPA and PETROPAR for a new concession (granted last of 1959) called Great Eastern Sand Sea close to Libya. A seismic crew has moved into the area.

Other U. S. companies in the area are Sinclair Petroleum Company, Newmont Mining Corporation, Delhi-Taylor through Canadian Delhi, E. Constantin, an independent, of Dallas, Texas.

Royal Dutch/Shell, which had the first venture outside French interests; British Petroleum; Ausonia Mineraria, an Italian firm; Wintershall, Deutsche Schachtbau, and Gewerkschaft Elwerath, German companies, are some other foreign firms that have invested in Saharan operations.

What of the Future?

Oil and gas can transform the North African area if political differences do not close down operations. In French industrial circles it is emphasized that the Sahara, bordering on Algeria, has been no man's land before the French opened it up by building roads and — more recently — by exploring it for oil deposits. Even if an independent or semi-independent government is formed in Algeria, their power would most probably be restricted to the area inhabited by Algerians, but would not include the Sahara, whose economic exploration has been and will probably remain in the hands of the French.

It would be interesting to see uninterrupted progress in Algeria/Sahara where cheap energy could bring industrialization and great changes in agriculture. The poorest departments in the French Republic could become its most thriving.

Recent reports are that French government capital expenditure the Algerian/Sahara in 1960 is estimated at $532 million. To finance the fund, 5 percent bonds are being sold in the Paris market.

If only siestas were forced on politicians!

TABLE 5. WELLS COMPLETED IN ALGERIA-SAHARA.

Year	Exploratory			Development			Total Wells
	Oil	Gas	Dry	Oil	Gas	Dry	
1959	7	4	25	106	7	7	152
1958	2	4	33	62	8	6	125
1957	0	10	20	22	2	3	57
1956	3	5	28	9	0	1	56
1955	0	1	21	6	0	13	41
1954	0	1	17	20	0	20	58
1953	0	0	11	29	0	16	56
1952	0	0	11	28	0	4	43
1951	0	0	12	12	1	4	29
1950	0	0	14	10	0	0	24

TABLE 6. OIL AND GAS FIELDS JANUARY 1, 1960.

Fields	Date of Discovery	Number producing wells	Producing depth	Present production, b/d	Cumulate production	API gravity
Oued Gueterini (CAREP)	1948	14	1100–1600	40	2,554,881	39°
Edjeleh (CREPS)	1956	80	1600–2600	—	—	32-42°
Hassi Messaoud (CFPA-SN REPAL)	1956	50	11,150	21,000	9,162,000	45°
Hassi er R'mel (SN REPAL)	1956	10	6900–7400	gas-condensate		
Tiguentourine (CREPS)	1956	11	1970–3940	—	—	44-48°
Zarzaitine (CREPS)	1958	53	4265	—	—	44°
Bordj Ne'i (SN REPAL)	1958	2	8200			
El Adeb Larache (CREPS)	1958	2	4920			
El Agreb (SNPA)	1959	3	10,537			
El Gassi (SNPA)	1959	8	11,000			44°

Note: Except for old Oued Gueterini field and Hassi Messaoud, all others are shut in awaiting pipe lines.

IN ONE CREPS BLOCK near Libya you find this rugged surface. Beneath are such rich fields as Edjeleh, Tiguentourine, and Zarzaitine. — *Photo courtesy Bureau de Recherches de Petrole.*

DIRECTORIES FOR ALGERIA/SAHARA

Oil Operators

AFROPEC — Africa-Cities Service Petroleum Corp.
El Biar (Alger): Villa Bel-Air, Chemin Louis Honoré. Box 19. Cable: AFCITCO EL-BIAR. Tel: 745-00. Directeur de l'Exploration: R. M. Bradley.

AMIF — Ausonia Miniere Francaise.
Alger: Immeuble El-Djezaif, 1 Place Lyautey. Tél: 459-25. Mgr: M. Bouchet-Virette.

CEP — Compagnie D'Exploitation Petroliere.
Alger: 6, Boulevard Saint-Saëns. Tél: 317-03 — 318-57. Mgr: M. Estebe.

CFIM — Compagnie Franco Industrielle et Maritime (Franco-Wyoming).
Paris: 24, Place Vendôme. Tél: OPEra 01-80. President: M. Henri Gaillochet.

CFPA — Compagnie Francaise des Petroles (Algerie).
Hydra (Alger): Ancien Lotissement Peltzer-Raynouard. Box 2 Plateau Saulière. Tél: 625-18-19 — 647-77 — 656-50. Directeur Général adjoint: M. Germes.

COPAREX — Compagnie de Participations de Recherches et D'Explorations Petrolieres.
Paris 8: 1 rue d'Astorg. Tél: ANJou 59-36. Président-Directeur Général: M. Louis Eyssautier.

COPEFA — Compagnie des Petroles France-Afrique.
Alger: 29 Boulevard Carnot. Tél: 366-06 — 348-06. Chief de Base: M. Henry.

CPA — Compagnie des Petroles D'Algerie (Royal Dutch/Shell 65%).
Alger: 7 rue Daguerre. Cable: COPETRAL-ALGER. Tél: 471-90 to 94 — 470-72 to 74. Directeur Général: M. Bachollet.

CREPS — Compagnie de Recherches et D'Exploitation au Sahara (Royal Dutch/Shell 35%).
Alger: 5 rue Daguerre. Cable: RAPETROL-ALGER. Tél: 475-60. Directeur: M. Samuel.

ESSO — Compagnie Esso Saharienne.
Alger: 126 ter rue Michelet. Tél: 501-68. Chef Exploration: M. Dorreen.

EURAFREP — Societe de Recherches et D'Exploitation de Petrole.
Alger: 2 Boulevard Saint-Saëns. Tél: 370-82 to 86. Délégué: M. Bonneau.

FIP — Franco Internationale des Petroles.
Paris (jer): 24 Place Vendôme. Tel: OPEra 39-49. Directeur: M. J. Desservre.

FRANCAREP — Compagnie Franco-Africaine de Recherches Pètrolieres.
Alger: Immeuble El-Djezair, Place Lyautey. Tél: 390-74. Mgr: M. Favier.

FRANDEL — Franco-Delhi S.A.
Alger: Immeuble El-Djezair, Place Lyautey. Cable: FRANDEL-ALGER. Tél: 399-64 to 66. Directeur de l'Exploration: M. James M. Corry.

OMNIREX — Omnium de Recherches et Exploitations Petrolieres.
Paris 7: 280 Boulevard Saint-Germain. Tél: INValides 15-30. Président-Directeur Général: M. L. Bricard.

OVAIM—Omnium de Valeurs Agricoles, Industrielles et Minieres.
Paris 2: 10 rue Volney. Tél: OPEra 17-01. Président-Directeur General: M. Lacaze.

PECHELBRONNREP — Societe de Recherches et D'Exploitations Petrolieres.
Paris 17: 4 rue Léon-Jost. Tél: CARnot 07-80. Président-Directeur Général: M. Ch.Lambert.

PETROPAR — Societe de Participations Petrolieres.
Alger: Immeuble El-Djezaïr, Place Lyautey. Tél: 397-22/23. Bureau d'Alger: M. Jusserand.

PETROSAREP — Petrofrance.
Alger: 88 rue Michelet. Tél: 566-39 and 553-96. Directeur: M. Viguier.

PHILLIPS — Phillips Petroleum Cie France — Phillips Petroleum Company et Drilling Specialties Company.
Alger: Immeuble El-Djezaïr, 1 Place Lyautey. Tél: 382-58. Chef du Service Administratif: M. David G. Sidebottom.

PREPA — Societe de Prospection et D'Exploitations Petrolieres en Alsace.
Alger: 12 avenue du Général Yusuf. Tél: 588-90. Directeur adjoint, Chef du Secteur: M. Rey-Grange.

SAFREP — Societe Anonyme Francaise de Recherches et E'Exploitation de Petrole.
Alger: Dir. et Adm., Immeuble El-Djezaïr, 1 Place Lyautey. Tél: 378-01. Exploration et Technique, 6 Boulevard Saint-Saëns. Tél: 389-45 et 46. Géologue, Chef de Mission: M. Payan.

SINCLAIR — Sinclair Sahara.
Alger: 4 Boulevard Saint-Saëns. Tél: 393-42. Directeur Exploration: M. Bernard.

SNPA — Societe Nationale des Petroles D'Aquitaine.
Alger: 2 Boulevard Saint-Saëns. Tél: 378-42 et 43. Directeur: M. Enous.

SNREPAL — Societe Nationale de Recherche et D'Exploitation des Petroles en Algerie.
Hydra (Birmandréis): Rue de l'Aspirante Denise-Ferrier. Box 105-ALGER. Tél: 625-80. Cable: REPAL-ALGER. Directeur Général: M. Colot.

SPV — Societe des Petroles de Valence (British Petroleum 50%).
Alger: 126 bis, rue Michelet. Box 46 — ALGER-Plateau Saulière. Tél: 617-34 à 36. Cable: SOPEVAL-ALGER. Directeur. M. Faucompre.

Geophysical Companies

CATG — Compagnie Pour L'Application des Techniques Geophysiques.
La Glaciere (Hussein-Dey): M. Mestas C/o Alexis Freche. Tél: 714-29.

CFPS — Compagnie Francaise de Prospection Sismique.
Alger: 7 Rue Drouillet. Tél: 468-83. Mgr. M. Vanroyen.

CGG — Compagnie Generale de Geophysique.
La Redoute (Alger): Immeuble "Dans les Arbres" — Chemin Shakespeare. Tél: 551-82 à 85. Mgr: M. Bouchon.

CRG — Compagnie Reynolds de Geophysique.
Hussein-Dey (Alger): Rue Auguste Cahours. Mgr: M. Boris.

EGR — Exploration Geophysique Rogers.
Alger: 17 Rue Edgar-Quinet. Cable: ROGERCO. Tel: 589-49 et 564-92. Chef d'Exploration: H. W. Beauchamp.

INDEPENDEX AFRIQUE — Independent Exploration Company.
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CISA — Societe Commerciale et Industrielle Du Sahara.
Alger: 1 Place Lyautey (Imm. El-Djezaïr). Tél: 393-25 et 26. Mgr: M. Eschesseriaux.

CONTINENTAL-EMSCO (drilling and producing equipment)
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Alger: 1 Rue Joinville. Tel: 485-56. Cable: UNAFRIC. Pres: Andre Miller

CSH — Compagnie Saharienne D'Habitation et D'Hotellerie.
Alger: 59 Rue d'Isly. Tél: 398-66 et 469-92. Mgr: M. Richard.

COSAGRA — Compagnie Saharienne de Groupage et D'Affretement.
Alger: 1 Place Lyautey (Imm. El-Djezaïr). Tél: 393-51 à 53. Mgr: M. Bonvillain.

COSERVICES — Compagnie des Services Petroliers.
Hussein-Dey (Alger): Rue Auguste Cahours. Mgr: M. Fourney.

CRAELIUS (diamond bits)
Alger: 17 Rue Denfert-Rochereau. Tel: 388-44. Cable: CRAELIUS-ALGER.

CSEE — Compagnie de Signaux et d'Entreprises Electriques.
Alger: 78 Ave. Yousouf. Tel: 620-03.

FAILING, GEORGE E. (drilling rigs).
Distributor: Societe Imex
Alger. 32 Rue Polignac.

GREP — Groupement des Societes Entrpose et Parisienne Pour L'Industrie Electrique.
Alger: 14 Bd du Pr. Doumer. Tél: 552-41 et 42. Mgr: M. Wuchner.

GTS — Groupement Technique et Financier Pour le Sahara.
Alger: 59 Rue d'Isly. Tél: 398-66. Mgr: M. Fontaine.

IDECO-DRESSER — (drilling rigs, drilling and producing equipment).
Distributor: Neyrpic-Afrique.
Hussein-Dey (Alger): Rue Ste-Claire-Deville — Côte Rouge. Box 523. Tél: 722-23. Cable: ALNEY-RPIC. Mgr: M. Guinchard.

INTERNATIONAL HARVESTER EXPORT CO. (crawler-tractors, oil field and exploration equipment, pipebooms, power units, engines, motor trucks).
Distributor: CIMA — Compagnie Internationale des Machines Agricoles.
Alger: 50-52 Blvd. Thiers. Mgr: J. L. Marinot.

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Distributor: Ets. G. Musso.
Alger: 126 bis, Rue Michelet. Tel: 693-31. Cable: OSSUM. Mgr: Louis Vaccaro.

NATIONAL SUPPLY COMPANY (oilfield supplies).
Distributor: Societe Imex.
REP: N. E. Duff (Armco-France).
Alger: 32 Rue Polignac. Cable: IMEX. Mgr: Jean L'Hostis.

ONAN, D. W. & SONS (electric plants, generators air-cooled engines).
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Alger: 27 Blvd. Carnot.

OTP — Omnium Technique des Transports Par Pipe-Lines.
Alger: 3 Rue Denfert-Rochereau. Tél: 488-39 et 380-72. Mgr: M. Villeplet.

OTS — Omnium Technique Saharien.
Alger: 39 Rue Burdeau. Tél: 391-71. Mgr: M. Tessier.

PESCHAUD & CO.
Alger: 4 Rue Monge. Tél: 373-54 & 55. Mgr: M. DeBernede.

SAEB — Societe Algerienne des Etablissements Brossette.
Hussein-Dey (Alger): 3 Rue de Constantine. Tél: 727-90.

SAHARA — SERVICE
Alger: 6 Bd Laferrière. Tél: 313-90 et 91. Mgr: M. Miville.

SCTR — Societe Commerciale de Transports Aeriens — Maritimes et Terrestres.
Alger: 15 Rue Charras. Tél: 311-91 à 97. Mgr: M. Saint-Guily.

SDRS — Societe Pour le Developpement des Regions Sahariennes.
El-Golea. Mgr: M. Albrand.

SELIS — Societe D'Equipement Pour L'Infrastructure Saharienne.
C/o SCET — Sté Centrale d'Equipement du Territoire.
Alger: 8 Rue Monge. Tél: 391-80. Mgr: M. Vallee (Directeur Régional OUARGLA).

SGR — Societe Generale de Ravitaillement — General Supply Company.
Alger: 15 Rue Chambéry. Tél: 356-13. Mgr: M. Savon.

SHRM — Societe Hoteliere et de Ravitaillement Maritime.
Alger: 80, 81, 82 Qua Sud. Tél: 302-98 et 319-69. Mgr: M. Monie.

SIF — Sondages — Injections et Forages — Entreprise P. Bachy.
Alger: 4 Bd St-Saëns. Tél: 308-49/50. Mgr: M. Mabillot.

SMF — Societe de Fabrication de Materiel de Forage.
Alger: 32 Rue Polignac. Tél: 566-28 à 30. Président: Dr. Gal. Cable: IMEX. Mgr: Jean L'Hostis.

SN MAREP — Societe Nationale de Materiel Pour la Recherche et L'Exploitation Du Petrole.
Hussein-Dey (Alger): Rue Négrier prolongée. Tél: 726-00/01. Mgr: M. Malterre.

SOCIETE L'HYDRAULIQUE AFRIQUE.
Alger: 116 Bd Télemly. Tél: 404-52 et 401-12. Mgr: M. Barron.

SOCIETE SOLETANCHE.
Alger: 68 Rue Michelet. Tél: 695-01 — 691-11 — 691-35. Mgr: M. Masson.

SOCOMAN — Societe Commerciale et Miniere Pour L'Afrique Du Nord.
Alger: 21 Bd Marcel-Duclos. Tél: 695-44 à 46. Mgr: M. Giboin.

SOPEG — Societe Petroliere de Gerance.
El Biar (Alger): 38 Rue de Verdun. Tél: 740-51 et 748-27.

SPE — Societe de Prospection Electrique.
El-Biar: Villa Boukandourah Rue Finalteri.

SVHNA — Societe des Hotels et Voyages Nord-Africains.
Alger: Gare Maritime. Tél: 203-30. Mgr: M. Douguet.

TELE-SAHARA — Societe de Telecommunications Sahariennes.
Alger: 26 Bd Victor-Hugo. Tél: 386-64 et 380-29. Mgr: M. Fournier.

TRAPEGAZ — Travaux Petroliers et Gaziers.
Alger: 1 Rue du Languedoc. Tél: 392-46 et 392-82. Mgr: M. Galy.

TRAPIL — Societe des Transports Petroliers Par Pipe-Line.
Distributor: OTP — Omnium Technique des Transports par Pipe-Lines.
Alger: 3 Rue Denfert-Rochereau. Tel: 488-39. Mgr: M. Jacot.

WILLIAMSON, T. D. (scraping pigs, batching pigs, tapping machines, stopple plugging machines).
Distributor: Petrochimie-Algerie.
Alger: 12 Ave. Pasteur. Tel: 351-93.

Drilling Contractors

ALTRAVEN — Societe Algerienne de Travaux de Recherches et D'Enterprises.
Maison-Carree (Alger). Rue de l'Aures. Tel: 760-29. Manager: M. Panissal.

CITRA-CAMAY — Compagnie Industrielle de Travaux — Camay Drilling Co.
Alger. 56 Blvd. Bru. Manager: M. Verstraeten.

COFOR — Compagnie Generale de Forage.
Alger: 116 Blvd. Telemy. Engineer: M. Denest.

EFNA — Enterprise de Forage Nord-Africaine — Deutsche Schachtbau S. A.
Alger. 6 Blvd. St. Saens. Tel. 32119. Cable 91054 EFNA. Manager: Dr. Gert Backes.

FORASOL — Societe Forasol
Alger. 8 bis, Rue de Mulhouse. Manager: M. Cormier.

FORENCO — Compagnie Nouvelle de Forages Petroliers.
Alger. 38/40 Rue Michelet. Manager: M. Sagnier.

INTERFOR — Societe Internationale de Forages Petroliers.
Alger. 15 Rue Charras. Tel: 381-80. Manager: M. Fainelli.

LANGUEDOCIENNE—Societe Languedocienne de Forages Petroliers.
Hussein-Dey (Alger). Rue Aug. Cahours. Manager: M. Huet.

LTS — Les Travaux Souterrains
El Biar (Alger). Place Bir-Hakeim. Manager: M. Bernardou.

NORAFOR — Societe Nord-Africaine de Forages et D'Exploitations Petrolieres
Maison-Carree (Alger). Rue de l'Aures. Manager: M. Schwartzmann.

SIFOREP — Societe Industrielle de Forages, De Recherches Et D'Exploitations De Petrole.
Alger. 4 Blvd. St. Saens. Manager: M. Mabillot.

SOGEFOR — Societe Generale Des Forages Petroliers.
Hussein-Dey (Alger). Rue Auguste Cahours. Manager: M. Masson.

HOW TO BE A MANAGER

Do You Have What It Takes To Be a Manager?

Carl O. Tongberg

"Management is the dynamic, life-giving element in every business" — Peter F. Drucker

ALMOST EVERYONE wants to be a manager, or — to put it more bluntly — a boss. In the great majority of people this is an instinctive desire. Babies try to get their own way with their parents even before they can talk. Children playing games try to boss each other. And husbands and wives sometimes get into disputes over which one should rightfully manage a facet of family life.

Professional people, trained to think independently, have particularly strong desires to be their own boss. But relatively few men have sufficient managerial ability to go along with their inborn desires to manage, and their failure to recognize this lack can produce serious problems.

In industry, there can be especially unhappy results when a man achieves a managerial position despite inadequate ability. His organization will suffer, as is obvious, but so will he. Finding himself in over his head, he will live from then on in an atmosphere of worried insecurity. Conversely, problems ensue when a man never does attain a managerial position despite a driving ambition to get there. His lot is bound to be one of frustration, characterized by a sharply declining interest in both his company and his job.

It is important, then, for a man who aspires to a management job to ask himself point blank: "Do I have what it takes to be a manager?"

To learn this answer, and it can be an elusive one to pin down, he must start with some honest soul-searching in regard to his motivation. Why does he want to be a manager? Is it the prestige? The supposedly high earnings? The nice office, the trappings, the privileges? Or is he truly moved by a desire to help shape the course of his organization — *because he feels he has something tangible to contribute to its success?*

If the would-be manager can satisfy himself that his motivation passes muster, he must then examine in critical detail the elements that make up a successful manager. He will learn that management jobs can be far more complex than he realized, the sacrifices far more extensive, the responsibilities far greater.

Let's review some of the essentials:

He has broad interests. He thinks in terms of overall company objectives, and the ways and means of achieving these objectives. He has a thorough grasp of the needs of his organization, and in some cases spends a considerable amount of time in establishing just what the needs are.

If he rose to a manager's position partly because he was exceptionally competent in his own special field, he has since learned to consider that special field in its proper perspective in regard to overall operations, neither favoring it nor slighting it.

He has an analytical sense of organization. Knowing what the company goals are, he organizes his people and the work so that the operation is effective, efficient, and flexible enough to provide the right results. His approach to organization is practical and realistic, but it also leaves room for imagination when there are unusual demands.

He is willing to shoulder responsibility. The expression from an old joke, "Decisions, decisions, decisions!", is not funny to him. Making decisions, big ones and little ones, day in and day out, is a key part of his managerial life.

And some of them can be devilishly difficult to make, especially when they concern the morale of the people he's managing, or when a sizable sum of other people's money is involved.

He is creative. He has a strong desire to improve the operation for which he is responsible. He is never satisfied completely with the status quo, but is constantly mulling over ways to improve the way the job is being done from the standpoint of quality, or costs, or time.

He knows the importance of delegating responsibility. He has learned that one man can't do everything, that the man who tries is not really a manager at all. And yet, at the same time he keeps himself abreast of the progress made, and problems encountered, by the subordinates to whom he has delegated responsibility.

He appreciates the importance of human relations. He has the ability to direct people by instilling in them a desire to do their best. He knows how to engender the spirit of teamwork within his organization, and he can quickly and fairly settle the petty disagreements that pop up like mushrooms when people work together closely.

He appreciates their desire to get ahead, and encourages their training and development. He knows how to judge

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A native of Lynn, Massachusetts, he received his bachelor's and master's degrees from Harvard University, and his PhD from Pennsylvania State University.

subordinates on present performance and on future potential, and he knows how to pick the right men for jobs.

He also has the fortitude to face facts when ineffective people on his staff place the entire operation in jeopardy, and need to be weeded out. Finally, in relationships with his staff people, he knows when to be soft and when to be hard . . . when to be encouraging and when critical . . . when to be informal and when formal. In all cases, he knows his main job is not to be popular with his people. His job is to get the necessary work done.

✓ **He is a good communicator.** His is a two-fold communication job: He reports upward, to the management level above him, and downward, to the people who work for him. He is articulate in both his written and oral reporting. He makes his points with clarity and brevity — and, most important, with conviction. At no time does he forget he has an obligation to keep his superiors and his staff fully informed of all pertinent developments.

✓ **He can "sell" his ideas.** He appreciates that a good idea doesn't sell itself, and so he is a salesman who has learned to compete on equal terms with other managers eager to have their ideas accepted by top management. In conjunction with his ability to present ideas convincingly, he has learned how to handle the often discouraging job of repeatedly justifying his present and future operations.

These are the more obvious qualifications of the man who is a successful manager. There are other aspects of the job that are less visible to the naked eye.

SOME SPECIAL NEEDS

It is no joke that a good manager *needs an understanding wife and family*. His responsibilities can mean long hours of work at night and on week ends, either in his own home, at the office, or — in the case of a business trip — in a plane, a train or a hotel room in a distant city.

Unexpected problems may mean abruptly cancelled social plans. Friends invited over to play bridge have to be asked not to come after all. Junior's long-awaited trip to a ball game or the circus with his Dad disintegrates before his eyes.

These are unpleasant moments in the life of a good manager, but when it's important enough he must put the company ahead of his personal life.

He must be able to *adapt to the lonely life a manager can expect to live in a company*, for he is neither "one of the boys" in his own organization nor completely one of the group at the next level. There are parts of his responsibilities that he can share with no one, and even when he can and does share the load, the responsibility in the final analysis is his and his alone.

He *must be an avaricious reader*, digesting information and ideas from a broad selection of magazines, newspapers, and books. As a manager, he is expected to be thoroughly knowledgeable, not only in his own field of endeavor but in many related fields as well.

He *must be a good listener*, a man of infinite patience, a boss who is both considerate and thoughtful. Having departed from the ranks of job-holders who work from 9 to 5, he has to be ready and willing to provide the extra effort every time it's needed.

CHECK LIST OBJECTIVELY

The man who wants to be a manager should be able to reach some definitive idea of how well he'd do at the job by using the points outlined above as a general checklist. It is not always possible to be completely objective about one's abilities, however. Some of the weakest potential managers delude themselves into believing they are naturally blessed with top administrative qualities.

Fortunately, a man usually is introduced to management work on a gradual basis. It is when he is getting just a taste of all that managing means — the good things, the bad things, the hard things — that he should make his most honest self-appraisal.

If he finds he likes it — all of it — and is successful at it, then he owes it to himself to do everything he can to strengthen and develop his administrative characteristics. He should seek out special courses that will bolster his weak points; apply for on-the-job training; embrace willingly the opportunity for rotational assignments. Further, he should discipline himself to begin thinking as a member of the company's management team. To do otherwise would be a waste of his own resources.

But, if he's not sure he does like managing, whatever his reason, he should have the courage to acknowledge to himself and to his company that he's out of his element. In the long run, by doing the type of work he is best qualified to do, both he and his company will be better off.

Some Provocative Questions:

1. Are you satisfied with your ability as a communicator?
2. Are you the kind of man you'd like to work for?
3. Do you worry about things that cannot be changed?
4. Are you interested in helping other people in the organization do a better job?
5. Are you still trying to learn?

There Are Ideas in These:

[1]*Steckle, Lynde C., The Man in Management, Harper and Brothers, New York, 1958.*
[2]*(Staff Written), Managers Need 3 Smart Teachers, Nation's Business, Washington, D. C., January, 1957.*
[3]*Allen, Louis A., Management and Organization, McGraw-Hill, New York, 1958.*

Villa Camille, Hunt, Texas, is site of five-weeks course.

Texas University Has Concentrated Executive Study

Program remains flexible under constant review of Advisory Committee

Virgil A. James

THROUGHOUT the Free World today there are more than 100 university executive development programs. Of these, less than half are in the United States and Canada. Others are in Europe, Asia, South America and Australia.

Only a handful were in existence prior to World War II, but in recent years they have become increasingly popular. The growth trend in university executive training together with like trends in in-company training evidence universal awakening to the fact that executive leadership is the backbone of private enterprise and the democratic way of life.

The University of Texas Executive Program is a part of this great trend. It came into existence upon request of a number of leading Texas businessmen, many of whom presently serve on the Advisory Committee. The oil industry is represented by J. L. Latimer, senior vice president, Mobil Oil; John F. Lynch, president, La Gloria Oil and Gas; L. F. McCollum, president, Continental Oil; and Gardiner Symonds, president, Tennessee Gas Transmission.

One or more times each year these men meet with representatives of The University of Texas to review program accomplishments and to consider ways of improving the program's service to business and industry.

Featured in this five-week educational program are a variety of planned experiences essential to executive maturity. The course content, faculty, methods of discussion, length and location of program, etc.—all have been carefully selected to supplement, but not duplicate, in-company training of executives. Specific objectives are:

To develop a clear understanding of executive functions and responsibilities.

To increase each participant's ability to think, to analyze, to reason and to resolve management problems involving both technical and human factors.

To provide for an exchange of useful knowledge, ideas, views and practices among executives from a cross section of business and industry.

To improve each person's ability to work successfully with other people.

To develop personal attitudes, insight, work habits and motives essential to executive maturity and competence.

A maximum of 36 seasoned executives representing a variety of industries and managerial responsibilities immediately below the top-management level are brought together in this program annually under ideal learning conditions at the Villa Camille, Hunt, Texas. The program site is far removed from busy city life and distractions affecting concentrated study.

Throughout the program, emphasis is placed on active participation by every member of the group. Differences in individuals' experiences, backgrounds, viewpoints and abilities vitalize the learning process as the participants make their contributions to case discussions, role plays, study groups, and informal gatherings.

An important feature of this program is its outstanding faculty. For example, the 1960 session of the program scheduled for March 14 - April 14, 1960, will include such outstanding discussion leaders as Professor Erwin H. Schell, of Massachusetts Institute of Technology; Professor Earl Brooks, of Cornell University; Professors James R. Hawkinson and Carroll R. Daugherty, of Northwestern University; Professor Theodore Kreps, of Stanford University; Professors William R. Spriegel, Glenn A. Welsch, and others, of The University of Texas. Under the guidance of these capable discussion leaders, participants find their thoughts, views, and conventional practices being compared and challenged both in and out of the classroom.

Classroom discussions are based for the most part on these subjects:

Attitudes and Human Behavior
Budgeting and Financial Control
Business Policies and Managerial Decision Making
Business and Society
Executive Leadership
Labor Relations
Marketing Management
Organizing for Business Action

These subjects are treated not as separate topics but as major components in the educational background of top-level executives. Although actual cases are used extensively, other teaching methods also are used, i.e., the panel, role play, informal discussion, study group, personal consultation, and the incident method. To encourage active participation by every member of the group, all discussion leaders live with the participants at the program site.

There are no tests or examinations. The real test of the program is felt to be the extent to which it helps each man improve his performance back on the job long after the program is over.

Tuition is $975, including fees, instruction materials, lodging, and dinner meals only. Classroom sessions are held from 8:00 a.m. to 4:30 p.m., Monday through Saturday noon of each week. Evening hours are devoted to study, case preparation, after dinner discussions, and personal consultation.

Ordinarily, executives attending the program are sponsored by their employer who pays the tuition and the executive's salary while in attendance at the program. Inquiries regarding this educational offering may be addressed to: Virgil A. James, Director of Executive Development Programs, Division of Extension, The University of Texas, Austin 12, Texas. ★ ★ ★

The author is director of Executive Development Programs.

THE NEW AMERICAN CAPITALISM

A sweeping account of the progress and changes in the U. S. economic system in the last 50 years . . . Advance in the future depends on specified obligations of government to business

Gardiner Symonds

ONE OF THE UNIQUE FEATURES of our American capitalism is the number of persons both in our land and abroad who have our economy under the magnifying glass or microscope. The economy is studied as if it were a new germ or chemical element, with intense interest and fixed attention.

It is counted. Its temperature is taken. It is graphed and charted. Facts are accumulated on the gross national product, and on the productivity index of key items. Continual indices are put together on the cost of living, the number of employed and unemployed, and on the stock market.

Yet perhaps it is not our economic system itself which generally gets the major attention, but rather its results. So first let's take a fairly brief and panoramic look at what we might call the results, or visible aspects, of the Old Capitalism 1909 vintage, half a century ago. Then let us compare them with the results of our 1959 economic system, or the New Capitalism.

1909

Among the most striking features of the economic scene 50 years ago, particularly in manufacturing and industry, were:

The extreme wealth of a comparatively small number of wealthy persons.

The extreme poverty of the many poor ones.

Then the yawning gap between, with no large middle class of moderately well-to-do persons.

It added up to a maldistribution of the fruits of the economic system, viewed by today's lights.

Average workers' wages were $400 to $500 a year, by various estimates, although reliable statistics are lacking. That was for a 10-hour day and 6-day week. Child labor was common. Immigrant labor, hitting a peak in 1907, flooded the country in excess of available jobs. This put in operation what an early economist called the Iron Law of Wages. It tended to minimize wages, and was one of the reasons why such organizations of labor as existed had little influence or power.

There was no income tax in 1909, nor would there be until four years later, in 1913. So some of the princely individual incomes of the time, ranging about $20 million per year, were all "take home pay."

Business was capitalistic in the old sense of the word. The owners of businesses, who had put up or obtained the capital to start their enterprises, ran them personally in a great many cases.

There were many corporations, although partnerships or family-owned businesses were much more common. Some corporations had several thousand stockholders, even then. But it was a day of scanty reports to stockholders, even in some cases, no reports at all for several years at a time. Much of the information corporations make public in a routine manner today was withheld 50 years ago as trade secrets which would benefit competitors.

Government played a minor, almost negligible role in business. Business was considered none of the government's business. The Sherman Anti-Trust Act was in effect but narrowly interpreted and little enforced. The government was small in men, money and powers. It was not the government but the great bankers of Wall Street headed by Pierpont Morgan who stepped in to restore confidence and end the 1907 bank panic.

In that day of unrestrained capitalism and individualistic, personally-dominated businesses, bankers had much more power and prestige than now. Morgan, an outstanding example, was the most influential figure in the national economy 50 years ago. He has no counterpart today.

Great captains of industry dominated and enlivened the business world. Besides Morgan, some of the others were Rockefeller, the Vanderbilts, Carnegie, Harriman. These were entrepreneurs, financiers, empire builders, renowned and admired for their drive,

Mr. Symonds presented this paper at the Twelfth Annual Businessmen's Day, Southern Methodist University, Dallas, Texas, April 7, 1959.

GARDINER SYMONDS is board chairman and president of the Tennessee Gas Transmission Company with headquarters in Houston, Texas. A native of Pittsburgh, he received his BA at Stanford and his MBA at Harvard. He is one of the most active figures in the natural gas industry of America. He has headed the company, which owns and operates the nation's longest natural gas pipeline system, since its formation in 1943. Prior to that time he was a vice president and director of the Chicago Corporation. His other interests are: Board chairman of Tennessee Life Insurance Company, The Bay Petroleum Corporation; Petro-Tex Chemical Corporation, Chaco Petroleum, S. A., Tennessee-Venezuela, S.A., and Tennessee del Ecuador, S. A., all of Houston, Tennessee Gas subsidiaries or affiliates; director of General Telephone and Electronics Corporation, General Public Service Corporation, both of New York; the Carrier Corporation of Syracuse, New York; Southern Pacific Company, San Francisco; The Food Machinery and Chemical Corporation of San Jose, California; and the National Bank of Commerce of Houston. Mr. Symonds is a member of the Business Advisory Council, Department of Commerce, vice chairman of the National Industrial Conference Board, member of board of trustees, Committee for Economic Development; board of governors, University of Houston.

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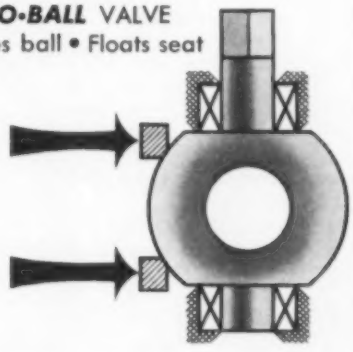

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boldness and creativeness.

The Old Capitalism also had its inventive geniuses, such as Edison, Bell, and Ford. Fifty-one years ago Ford brought out his famous Model T, which the customer could get in any color so long as it was black. Years were yet to pass, however, before he shocked the business world by raising wages to $5 a day.

It was a time when capitalism was a free-swinging contest between opposing groups of owner-operators who sought the quickest possible profit without regard for the interest of society.

And now let's leave the good old days, which in some ways were very good, but in others were equally bad. And step across a 50-year timegap to 1959 and the results of the New Capitalism.

1959

One of the most striking results of our economic system of today is that our citizens enjoy what, in my opinion, is the most widely and probably the most equitably distributed abundance the world has yet known.

I hasten to add a denial of any claim of perfection. In a rich economy buttressed by a paternalistic government, for example, it is sometimes hard to discern which of the poor we still have with us are so by the vicissitudes of fortune, and which others are too indolent to exert themselves.

In any event, the years have greatly narrowed the gap between rich and poor. Our economic pie is being sliced up more evenly. The amount of wealth to be distributed, the size of the pie, has grown greatly, outstripping population growth. So even in terms of constant dollars, real income grows and the national standard of living rises.

The narrowing of income differences has been accompanied by an even greater narrowing of ways of life. In 1909, the rich man often lived in a magnificent mansion tended by a retinue of servants, entertained lavishly, went abroad, spent his vacations at spas. He wore silk hats, cutaway coats, and other attire of quality and good tailoring. He and his equally well-dressed wife were like beings from another world when among groups made up of people with low incomes. The latter wore clothing obviously inferior in material and cut, often with little regard to style. Differing widely in background, education, customs and thinking, the rich and poor had little common meeting ground.

Today, the head of a company does not stand out in the crowd. His employees' appearance is much like his own. His secretary's frocks may be less expensive than his wife's, but they may follow the latest mode more closely.

In contrast to 1909, present-day Americans in great numbers have within their means not only the necessities but all the conveniences of life and many of its luxuries. Good homes with modern appliances, late model autos, vacations in Florida or California, even trips to Europe, are not exclusive prerogatives of the wealthy. Rather, they are enjoyed by or within the reach of a very large part of the population.

This elimination of differences in appearances and in other facets of ways of living is more important than it might seem. Doing away with such differences between the so-called classes is a long step toward doing away with the classes themselves.

In this respect as well as in others, we have moved — not toward socialism — but on past socialism, toward something better.

What has closed the chasm between ways of life of rich and poor? I will list seven causes; there may be more.

1. A major one is the **mass production and distribution of goods.** Luxury goods makers and sellers find it impossible to compete for the consumer dollar, luxury goods tend to disappear, and we all end up buying the same thing — with exceptions, of course.

2. The **spread of education** is a second cause. A mass movement of our youth into schools and colleges is occurring. It is as if Pied Pipers were operating throughout our land, but were leading the children into the classroom instead of making them disappear. Where 50 years ago only 1 out of 10 boys and girls of high school age went to high school, 8 or 9 out of 10 now do so. There has been a 700 percent increase in the number of students in college.

3. The **universality of travel** is a third. Country boys, traveling even involuntarily all over the world in World Wars I and II, came back noticeably broadened and educated.

4. **Mass-circulation communications** and media is still another. Magazines, movies, radio and television, carrying the same news, entertainment and advertising to practically everyone in the country, have made Americans more alike.

5. A fifth is the virtual **disappearance of the servant class** in this country. This has tended to make every woman her own housemaid. I might add that before we bemoan our hausfrau's fate, we should note that she often needs to hire a mechanic or engineer to maintain labor-saving devices in her home.

6. Another is the **disappearance of Society,** with a capital "S", as a social force. In its place is a fluid, rapidly-changing number of little societies, groups of people who gather socially, bound by ties of occupation, religion, participation in social work, or other shared experience. Change and informality are the rule of the day in most of these groups.

7. Seventh and last is the **trend toward informality,** which has become almost the common denominator of today's living. It is notable in men's and women's attire, in entertaining, in home life, and to some degree in business life. The wealthy have adopted it nearly as broadly as those of lesser means.

The New Capitalism

We have taken a look at some of the most visible *results* of the Old Capitalism of 1909 and the New of 1959. Let's now turn to our New Capitalism itself.

To start with, a question: Is our present economic system really capitalism at all? Differences of opinion exist, even among professors and economists. To some the system is brand new, to others it is capitalism, for the first time working as it should work.

It seems a matter of semantics, that rather inexact science of word meanings. I don't think the bare word "capitalism" is adequate. It carries negative connotations of cartels, restricted-production, high-unit-profit operations, and wealth in a few hands.

But adding the qualifying adjective "New" provides another and truer concept. For I feel our economic system has been tinkered with and modified; it has been affected greatly by government and importantly by organized labor. Yet basically it is still capitalism as outlined in the following definition:

I quote from Webster's Unabridged Dictionary:

"The established economic system of most modern civilized countries in which ownership of land and natural wealth, the production, distribution and exchange of goods, the employment and reward of human labor, and the extension, organization and operation of the system itself, are entrusted to, and effected by, private enterprise and control under competitive conditions."

Now I know the simple business of 1909 is a far cry from today's professionally managed corporation, with its broad ownership, complicated structure, and vital relations with government and labor. Sizable, complex businesses today cannot achieve their full potential without public good will, sound labor-management relations, and advanced administrative techniques.

But basically our economic system is still the same system, which works because it is sound psychologically and because it developed from peoples' desires and needs. And despite the inroads of government social security,

private business still provides modern pension plans, thrift contributions and long-time job security on a private enterprise basis.

To me, our economic watch keeps getting a different style case, a new face and different-type hands. We add gadgets, poke at it, clean it, and repair it. Generally it runs better afterward but sometimes worse.

But the important thing is, it tells time. That's because we haven't replaced the main spring. This, in our economic system, is the free enterprise incentive to work, save, invest, and take risks in order to make private profits and acquire private property.

The watch also tells time because we haven't removed the jewels. In our system they correspond to the free competitive market. There, price levels and the volume and nature of commerce are determined in trading between buyers and sellers, on the sensitive and flexible scales of supply and demand.

What's New About It?

Despite the retention of its basic features, the "new" in the New Capitalism is its most striking feature. What are some of its essential new characteristics?

Sheer bigness of the economy is one. This is true in all phases, but particularly in the market for goods. There are more people able to buy the things they need, or think they need, than in any country anywhere before.

Another new development is the marked complexity of the typical large business today. It is especially true of firms with diversified products and activities, with geographically widespread operations.

In such firms specialists are a necessity over a wide spectrum of operations. Management finds it advantageous to use their services in fields such as taxes, accounting, finance and economic forecasting, in law, in labor relations, public relations and employee relations, and in a variety of dealings with government.

Let me give you an example from our experience to illustrate this complexity. A tremendous volume of paper work is involved in some of our projects which require applications to the government for authorization. Several groups of specialists, 30 or 40 people in all, work 10 days or two weeks on the final stages of one of these applications, nearly day and night as deadline approaches. As many as 3,750,000 sheets of paper have been used for a single multiple-copy filing and the required supporting exhibits, contracts and studies.

Government in business characterizes the New Capitalism. We not only have a big complex economy. We have an equally big, complex government, which of course touches on and influences the course of business in ways too numerous to count.

Big government, like the New Capitalism, is different from anything we ever had before. It is larger, more powerful, and keeps growing.

That is partly due to the requirements of the cold war, our huge defense effort, and the current competition to explore and perhaps to occupy outer space. The complexity of our social system, and our increasing population and urbanization, have brought problems which seem almost insoluble except possibly by a central government.

For example, the government has taken on at least by implication such tasks as the prevention of depressions and the maintenance of employment on the one hand, and the stemming of inflation on the other. These goals are not necessarily irreconcilable, but they do require "about face, and to the rear march" maneuvers from time to time.

The spectacle we seem to observe at intervals, of one part of the government still battling depression and unemployment while the other part has reversed its field and has commenced or resumed the attack on inflation, I consider merely a sign of the times.

In our New Capitalism, government maintains some controls over business as a whole. It quickly extends them in time of emergency or war, and somewhat less speedily relinquishes them afterward. An example is price controls, kept in effect for about a year after World War II, each month less successfully.

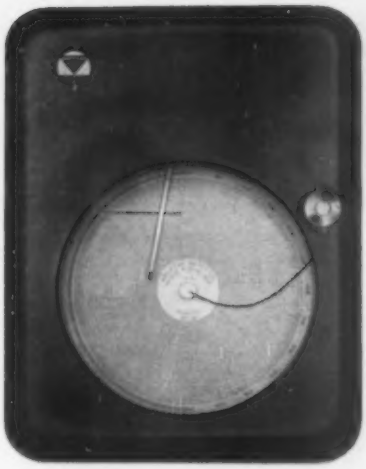
Government today is extended so far, and the national debt is so huge that questions arise with a vital bearing on the health of our New Capitalism. For instance:

1. *Can we keep on running deficits, increasing the debt and the debt limit, without impairing the national credit?*
2. *Can we raise our already high taxes without stifling production or even causing widespread tax evasion?*

Only time can answer.

And today, government does many things. But one thing it doesn't yet do is important to the New Capitalism. That is, it doesn't really run our private businesses. We who wear the hair-shirt of regulation may sometimes feel that it does. But when you get right down to it, even in closely regulated companies or industries, management makes the decisions, has the authority and must shoulder the responsibility for success or failure.

Our firm's business is involved with government almost continually on a



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broad front. We encounter many dedicated, able men in government who are doing the best job they can and very likely the best job anybody could do.

But government is essentially politics, and politics has been defined as the science of compromise. A natural consequence is indecision. A natural problem is how to get things done. For example, our company has had one major project waiting for government action for three and one-half years.

Based on my experience, government owes business four main obligations if it is to help further the New Capitalism of today.

1. It should provide **a favorable climate in which to work.** After all, the sound operation by business of our economic system is the foundation on which all our edifices of government, culture, education and even national defense and existence as a nation are built.

   Business does not need or expect any carte blanche for its actions. But those businesses which keep their house in order, and they are in the vast majority, deserve to know there is government understanding of their teamwork and approval in principle of the goals toward which business is working.
2. It owes business far-sighted policies which will **encourage initiative and stimulate putting capital to work.**
3. In its national and state labor policies, government should **foster the right to work, the opportunity to work** and the right to benefit from such work. It should not condone lassitude or featherbedding.
4. It should make **rules for business simple, clear and as stable** as possible. Changes should be evolutionary, not whimsical or revolutionary. And with it all, government owes fair and equal treatment to all business. The same rules for everyone!

In this year of 1959 when jet airliners have shrunk the earth for the ordinary traveler and outer space is daily losing its mysteries to man's determined probing, it behooves us in the business world to broaden our horizons and raise our sights, expand and secure the successes of the last 50 years and lay a sound base for even further progress.

We must continue to oppose centralization and paternalism in national government, and lend support to free enterprise as a keystone of the economic system — the New Capitalism — under which we have moved ahead to where we are today. ★ ★ ★

How to Combat Inflation

An economist proposes a new formula for forecasting the price level in getting at the basis of inflation

NOT LONG AGO a survey was taken by a national publication to find out what the people thought was the biggest problem of today. By far the most answers named inflation.

At least one famous economist has worked out what he terms an exact method of combating inflation. Sidney Weintraub, in his book "Forecasting the Price Level, Income Distribution, and Economic Growth" (Chilton Company, Book Division, 56th and Chestnut Streets, Philadelphia 39, Pennsylvania, price $5.00) presents two basic laws in our economy, which he believes are similar to and as exact as major laws of the physical sciences. His purpose is to eliminate the problem of whether inflation has been wage-induced with the cost-push dominant, or whether it reflects a demand-pull with the money supply and its velocity being the active agents.

First he develops and refines what he calls a "mark-up" factor (represented by a small k). This is the business gross product divided by compensation of employees on a national level.

$$k = \frac{\text{Business gross product}}{\text{Compensation of employees}}$$

From 1929 to 1957 he shows that this factor (k) has a narrow range of variability. It has stayed constantly near the 2.00 factor during almost 30 years.

The author calls this high constancy the most important economic law in the true sense that economists have to work with. He uses this factor to extract what he terms a new empirical truth or law in the proper operational sense; to wit, that a price rise can occur only if there is a rise in the ratio of average compensation to average productivity or vice versa.

Dr. Weintraub feels that the Federal Reserve Board of Governors has been miscast in the role of controlling inflation by controlling money. He denies that the Federal Reserve is equipped to combat inflation. Its operations take place via the money supply whereby it can exercise influence on the volume of lending, and thus, investment and consumption.

But it does not sit in on wage negotiations. Thus it has no way of preventing prices from rising when wages rise — unless it tightens money, accomplishes unemployment and eases the labor market.

The author's criticism of the Federal Reserve has been of the incompatibility between the job and the tool allotted. The wage level, not the money supply, governs the price level, declares Weintraub emphatically. A brake on monetary policy is a brake on output primarily. "The wage level, not the money supply, governs the price level."

He proposes that a small research agency be set up to collect data on all important wage agreements and estimate what their implications are for the price level. Once this information is available, he believes that union leaders and Congress would both find it useful.

Top people in the labor movement would know that a check was being kept on its demands and that the price level consequences were being judged by Congress. Businessmen, too, would come to appreciate that they might have to explain excessive wage bargains which were paid for by market price increases.

States the author, "I think, too, that this information not only ought to be gathered by a central agency organized specifically for the task — and it could be a *small* agency for the number of important and significant wage agreements are few — but also it should be available to all students of our economy to permit them to draw the correct inferences on why prices rose."

The nation must accept sooner or later the need for restraining the growth in wage rates, the economist states. Otherwise inflation as a way of life is being offered merely to avoid disturbing the bargaining exactions of union leaders and businessmen either unconcerned about or uninformed on the price level consequences of their acts, Dr. Weintraub believes. Once practical men realize that the Federal Reserve cannot be responsible for inflation, but that the unions and businessmen who concede to money-wage demands can be held responsible, there will be the restraint of reason.

The author holds a PhD degree and was trained at New York University and London School of Economics. He has been a professor of economics at the University of Pennsylvania since 1950. He has worked with the U. S. Treasury, Federal Reserve Bank of New York, etc. ★ ★ ★

DON'T LET *George* DO IT

THIS IS the "do-it-yourself" era. There's do-it-yourself furniture, television, hi-fi sets, home permanents and even paintings by the numbers.

Historians may someday point out that this mid-Twentieth century craze was the thing that stimulated a sagging interest in freedom.

"Before the do-it-yourself fad," they probably will write, "there was a 'let-George-do-it' attitude toward the government by-the-people system."

Regardless of what historians say a hundred years from now, the fact remains that there's a growing interest now in "do-it-yourself" type of activity in government that is inspiring to people who realize that the "let-George-do-it" attitude is fatal.

Next to voting and personal man-to-man conversation between the voter and the elected official, the most direct method of having a voice in government is to write letters to city, county, state and national representatives. They exist to represent the majority of the people. And it's obvious that if the majority doesn't make its opinions known, the minority may rule.

Many intelligent and interested voters tell neighbors, relatives and friends how they feel about key issues of city, state or national government.

Yet they fail to sound off where it counts . . . in a letter to the person who can do something about it.

There are a dozen reasons why voters never do it themselves. But one reason may be that they don't fully understand the procedure of writing to the senator, representative or councilman. There are no rigid rules; it's pretty much like writing anyone else.

The important thing is don't let George do it. Do it yourself. ★ ★ ★

Reprinted from *Sunray News*, company magazine of Sunray Mid-Continent, September-October 1959; Charles D. Schnake, editor.

HOW TO WRITE YOUR CONGRESSMAN

- Address your letter to:

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  United States Senate
  Washington 25, D. C.

  or

  Honorable John Jones
  House of Representatives
  Washington 25, D. C.
- This same type of address can be used for state senators, members of state legislatures and county or city officials.
- Be brief but clear and request specific action.
- Present your personal viewpoint and tell how the issue would affect you, your family, your community, etc.
- Use your own words. Canned or printed material isn't as effective. Personal letters usually receive prompt attention.
- Write legibly on one side of the page only and put your name and address at the top. Letters get more attention than postcards.
- Ask them to tell you what their present personal views are on the issue. And write to them, whether they belong to the same political party as you or not.

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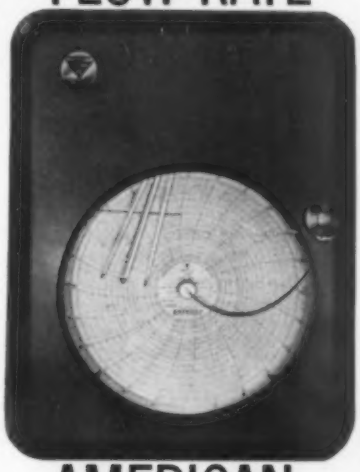

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Books To Read . . .

▸ **McAlester-Arkansas Valley Basin.** *Published by Rinehart Oil News Company, 2300 Reagan Street, Dallas, Texas. Pages, 230. Price, $17.50.*

Covering a finger-like strip extending from Coal County, Oklahoma, northeastward into East Central Arkansas, this special reference book contains information on 19 counties. The volume concentrates on discoveries, producing zones, number of wells drilled, deepest tests, formation records — plus field maps, key electrical logs, and nine exclusive aerial photographs. According to the publisher, growing interest in this possible boom area has generated a brisk demand for the limited edition.

▸ **Science and Resources,** *edited by Henry Jarrett. Published by The Johns Hopkins Press, Baltimore 18, Maryland. Pages, 250. Price, $5.*

Recently, Resources for the Future, Inc., sponsored six sets of public lectures in Washington, D. C., to review our present resource situation and expectations. This book is a collection of those essays. "Science and Resources" largely looks ahead, considering influences upon resources from the laboratory and industrial plant. Chapter topics are: (1) Genetics, (2) Weather Modification, (3) Exploring for Minerals, (4) Chemical Technology, (5) Nuclear Energy, (6) New Knowledge From Outer Space.

Although petroleum receives only casual mention, many of the collected articles will have useful information to industry readers.

▸ **Monograph in Economics,** *An investigation of the problems of cost determination for the discovery, development, and production of liquid hydrocarbon and natural gas resources. Authors: John E. Hodges and Henry B. Steele. Published by Rice Institute, Houston, Texas.*

The two authors, who are professors in the Rice Institute, have gone into the problem of economics and cost data in the petroleum industries in great detail and, like many before them, have found that reliable statistics are almost impossible to find. The monograph is addressed to a problem of both practical and academic interest. Industry and Government are concerned with the formation of policies and operating decisions pertaining to energy resources and this may be helpful in getting their own ideas resolved. As an academic problem, the determination of the cost of discovery, development, and production of liquid hydrocarbons and natural gas poses conceptual difficulties seldom encountered.

The discussion contains no final solutions to the many problems of cost determination that confront petroleum industry accountants, economists, and managers. An attempt is made only to clarify some basic cost concepts, and to suggest simplified procedures which may allow more meaningful cost data to be developed.

▸ **Power Unlimited . . . The Corruption of Union Leadership,** *by Sylvester Petro. Published by The Ronald Press Company, 15 E. 26th Street, New York 10, New York. Pages, 323. Price, $5.*

This much-needed book organizes into a coherent picture the facts revealed in the McClellan Committee hearings. It begins with a close look at some specific union practices as they are revealed in the Record. It describes in concrete detail how unwilling employees are organized "from the top" by stranger picketing and secondary boycotts; how terrorism and physical force are used in organizing campaigns; and how violence and mass picketing make a mockery of the process of collective bargaining. Testimony from the Record — by employers, workers, and union leaders — reveal some of the attitudes that underlie these abuses and demonstrates conclusively how corruption spreads from the leadership of the big unions into industry, government, and the moral fabric of society itself.

The author then turns to interpretation of the evidence. He believes that trade unions and collective bargaining have an important role to play in a free economy. But he holds that this role has been distorted by power-hungry labor leaders armed with special privileges granted to no other segment of society. Power unlimited, and society must defend itself by revoking the special privileges which make the abuses possible.

Meetings . . .

Mar. 2-4 — **API Division of Production,** southwestern district meeting, Statler Hilton Hotel, Dallas, Tex.

Mar. 6-9 — **American Society of Mechanical Engineers,** Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, Tex.

Mar. 7 — **Canadian Petroleum Assn.,** annual meeting, Palliser Hotel, Calgary, Alta.

Mar. 10 — **Petroleum Equipment Suppliers Assn.,** northern Mid-Continent district, Mayo Hotel, Tulsa, Okla.

Mar. 14-18 — **National Assn. of Corrosion Engineers,** annual meeting, Memorial Auditorium, Dallas, Tex.

Mar. 16 — **Petroleum Equipment Suppliers Assn.,** eastern district, Duquesne Club, Pittsburgh, Pa.

Mar. 16-18 — **API Division of Production,** southern district meeting, Hilton Hotel, San Antonio, Tex.

Mar. 18 — **Natural Gasoline Assn. of America,** Oklahoma regional meeting, Biltmore Hotel, Oklahoma City, Okla.

Mar. 21-Apr. 29 — **School of Gas Technology,** The University of Texas, 6th semi-annual term, Kilgore College, Kilgore, Tex.

Mar. 23 — **Petroleum Equipment Suppliers Assn.,** Pacific district, Ambassador Hotel, Los Angeles, Calif.

Mar. 28-30 — **Western Petroleum Refiners Assn.,** meeting, San Antonio, Tex.

Mar. 28-May 6 — **School of Pipeline Technology,** The University of Texas and API Division of Transportation, 8th semi-annual term, Lee College, Baytown, Tex.

Mar. 28-May 6 — **Institute on Automatic Production Controls,** The University of Texas and API Division of Production, first term, Odessa College, Odessa, Tex.

Mar. 29 — **Petroleum Equipment Suppliers Assn.,** Gulf Coast district meeting, Shamrock Hilton Hotel, Houston, Tex.

Mar. 29-31 — **American Power Conference,** Hotel Sherman, Chicago, Ill.

Mar. 30-Apr. 1 — **API Division of Production,** Mid-Continent district meeting, Broadview Hotel, Wichita, Kans.

Apr. 5 — **Petroleum Equipment Suppliers Assn.,** southern Mid-Continent district, Statler Hilton Hotel, Dallas, Tex.

Apr. 5-6 — **Gas Compressor Institute,** annual, National Guard Armory, Liberal, Kans.

Apr. 12-14 — **Petroleum Industry Electrical Assn. and Petroleum Electric Supply Assn.,** conference and exhibit, Kansas City, Mo.

Apr. 18-19 — **Conference on Automatic Techniques,** sponsored by National Conference Committee (ASME, IRE, AIEE), Cleveland-Sheraton Hotel, Cleveland, O.

Apr. 19-21 — **Southwestern Gas Measurement Short Course,** North Campus, University of Oklahoma, Norman, Okla.

Apr. 20-22 — **API Division of Production,** Rocky Mountain district meeting, Gladstone, Henning, and Townsend hotels, Casper, Wyo.

Apr. 20-22 — **National Petroleum Assn.,** semi-annual meeting, Hotel Cleveland, Cleveland, O.

Apr. 21-22 — **West Texas Oil Lifting Short Course,** Texas Technological College, Lubbock, Tex.

Apr. 24-26 — **Independent Petroleum Assn. of America,** midyear meeting, Denver Hilton Hotel, Denver, Colo.

Apr. 25-27 — **Southern Gas Assn.,** convention, Buccaneer and Galvez hotels, Galveston, Tex.

Apr. 25-28 — **American Assn. of Petroleum Geologists-Society of Economic Paleontologists and Mineralogists,** annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

Apr. 25-29 — **American Welding Society,** annual meeting and welding exposition, Hotel Biltmore, Los Angeles, Calif.

Apr. 27-29 — **Natural Gasoline Assn. of America,** annual convention, Rice Hotel, Houston, Tex.

Apr. 28-29 — **API Division of Transportation,** pipeline meeting, Mayo Hotel, Tulsa, Okla.

May 2-3 — **Society of Petroleum Engineers of AIME,** biennial North Texas secondary recovery symposium, Wichita Falls, Tex.

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Bucket capacity, 2 cu. yd.; bucket reach, 50¾ in. (@ 7 ft. dump height); over-all width (bucket), 93½ in.; wheelbase, 88 in.; speeds, forward (4), 0-24 MPH . . . reverse (4), 0-30 MPH; shipping weight, with diesel engine, 20,780 lb. — with gasoline engine, 20,440 lb.

HIGH LIFT, extra-long reach and safety! Note how bucket lift arms are completely in front of operator's area. This gives him new freedom of movement and greater all-round visibility. Other safety features: wide steps for safe and easy access from either side. Plus wide fenders that provide a handy engine checking platform as well as protection for operator from rocks and mud.

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DESIGNED FOR ACTION, controls provide instant, finger-tip shifting . . . a full range of work and travel speeds with reverse speeds 25% faster than forward speeds. Travel Range gives 2-wheel drive for roading . . . Work Range automatically puts power to all 4 wheels. Other action features: conveniently located machine and bucket controls . . . forward-reverse lever on the steering column . . . both bucket control levers with kick-out devices. Lift control releases at dumping height — tilt control positions bucket for digging.

DESIGNED FOR PRECISE CONTROL, the No. 944 brake system is outstanding. The left brake neutralizes the transmission as it stops the machine to provide superior loading action. The right brake leaves the transmission engaged for full control when creeping, etc.

VERSATILE IS THE WORD for the Cat No. 944 Traxcavator, which is offered with a full line of attachments and accessories to multiply its usefulness to you on *any* job. Available are forks, cab (shown here) and special buckets, including the exclusive side dump bucket.

Here's the first of a completely new line of equipment . . . the Cat No. 944 . . . rated at 2 cu. yd. capacity . . . that will soon include the No. 922 (1¼ cu. yd. bucket) and the No. 966 (2¾ cu. yd. bucket).

Watch for these new machines with the bold new design . . . they're ready to bring new standards to wheel loader operation. Take a look at the big new features that make this the easiest and fastest wheel loader to operate. Every feature is designed for *efficient work.* Plenty of horsepower . . . finger-tip steering . . . smooth, fast bucket action . . . outstanding operator comfort and safety.

Choose from two great new engines . . . the compact 4-cylinder Cat D330 Diesel Engine, turbocharged for maximum efficiency . . . or the 6-cylinder gasoline engine. Both are 105* HP units. Whatever your requirements, there's a No. 944 powered to meet your needs. Get the complete facts on the No. 944. See your Caterpillar Dealer the week of March 14. See for yourself how the new design pays off on your loader jobs!

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*For comparative purposes, the maximum rating of the Caterpillar D330 Diesel Engine used in the No. 944 is 135 horsepower.

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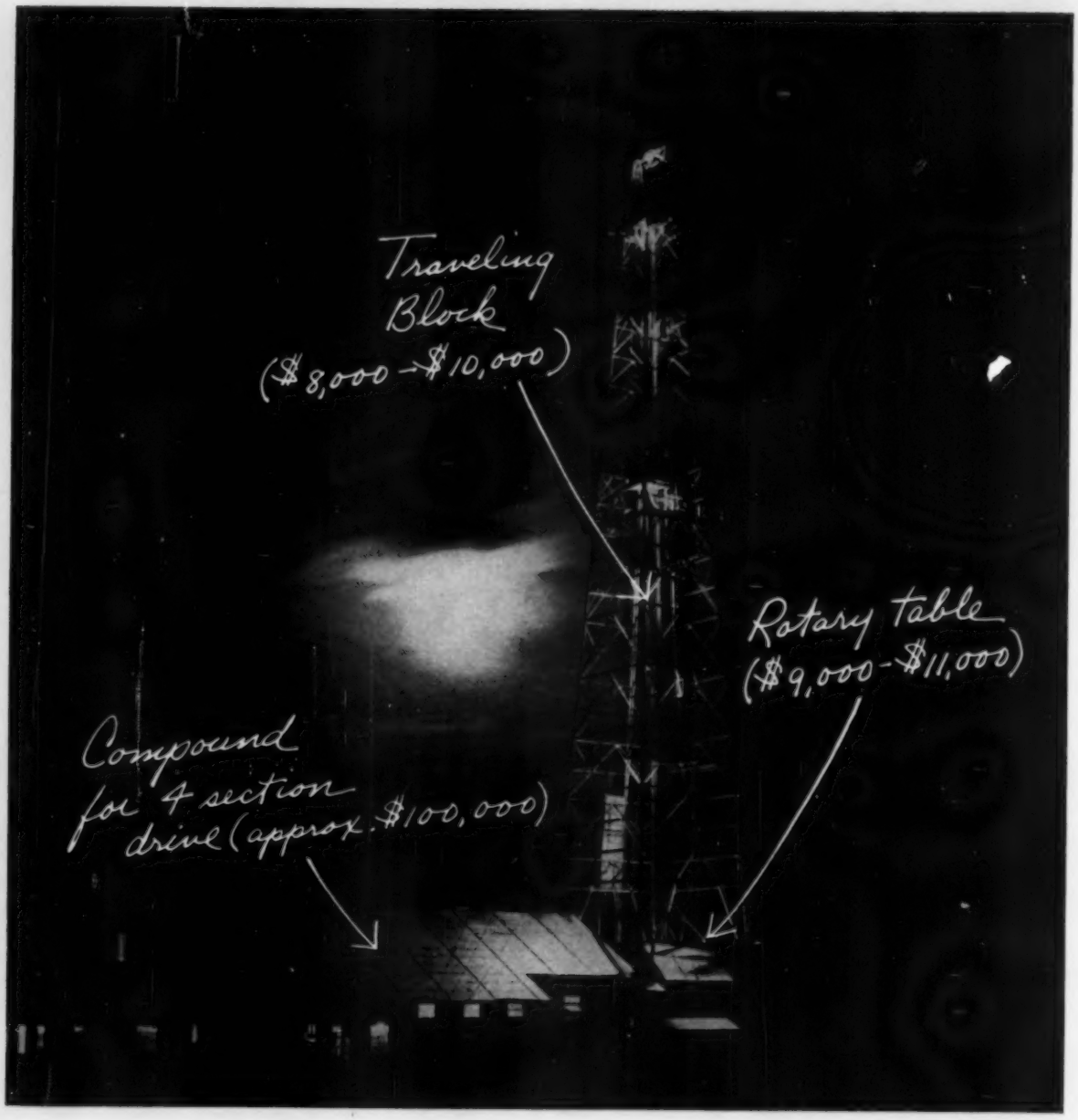

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This kind of investment precludes anything but the best. And, *anything but the best* can turn out to be the most expensive. Bargain hunting for "Economy" ropes when you lay out this kind of money is akin to putting five cent shoe laces in a pair of $40.00 shoes. Fool around with low grade ropes and you run into high grade troubles. On the other hand, a rope like Roebling Royal Blue can help protect your investment by *staying on the job.*

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Management Personals

A. C. Rubel

Albert Chatfield Rubel, president of Union Oil Company of California, has been awarded the Anthony F. Lucas Gold Medal, by the AIME at its annual banquet.

Mr. Rubel was selected: *"For his pioneering foresight in the application of engineering principles to petroleum development and production practices and for his fostering the development of many production techniques valuable to the petroleum industry. For his inspirational training and development of engineers not only to managerial, but also to social and political responsibilities."*

Born in Louisville, Kentucky, he was graduated, in 1917, from the University of Arizona with a degree in mining engineering and metallurgy. During World War I he received the Distinguished Service Cross for his service in the Corps of Engineers.

After working for oil companies in Mexico and Central America, he joined Union Oil in 1923 as an exploration geologist. In 1929, he became chief engineer and advanced until he became vice president in charge of exploration and production in 1939 and advanced to president in 1956.

Gordon C. Seeler was named marketing coordinator of The Enjay Company, Inc., Paramins Division. Seeler joins Enjay after more than 10 years with Esso Standard Oil Company, where he headed the process engineering division at the Bayonne refinery.

R.N. Peters, Reynolds' industrial divisional sales manager at Cincinnati, has announced the appointment of McJunkin Corporation, Charleston, West Virginia, as a distributor of aluminum pipe for Reynolds Metals Company.

Thomas W. Hunter was appointed general manager, operations-steel of United States Steel Corporation. Prior to his appointment, Hunter had been general superintendent of the Gary Steel Works, Gary, Ind.

George H. Fancher, petroleum engineering department chairman of the University of Texas, has joined Sinclair Research Laboratories Inc. at Tulsa as vice president in charge of production research. He has been a petroleum engineering professor at the university since 1935 and department chairman since 1956. **Dr. H. H. Power** will take over as acting department chairman. Dr. Fancher was one of the founders of the Texas Petroleum Research Committee.

A. Martin Eichelberger, marketing executive and petroleum exploration authority, joined Dibrell and Company, Inc., a Philadelphia-based firm of management consultants, as a participating partner and executive vice president in charge of marketing development. Prior to joining Dibrell and Company, he was associated with Aero Service Corporation of Philadelphia.

John F. Curran, senior attorney at Sunray Mid-Continent Oil Co. and former Superior Court judge at Enid, Okla., was named assistant general attorney for the company.

An attorney for Sunray since 1952, Curran served as assistant attorney general in the Justice Department in Washington, D. C. from 1946 to 1950.

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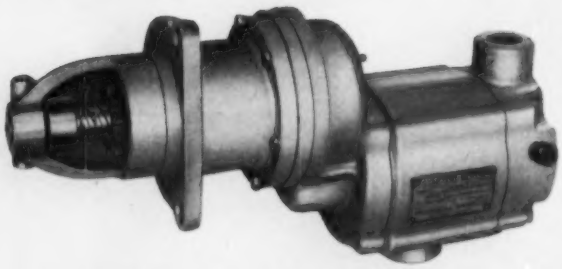

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Personals

D. L. Campbell

▸ British American Oil Company Ltd. has elected **D. L. Campbell,** former senior vice president, to executive vice president, and **C. D. Shepard,** general counsel, to a vice president and membership on the board. Shepard, in addition to being a vice president, will continue to be the company's general counsel. Campbell is a director of the Trans-Northern Pipe Line Company and B. A. Shawinigan Ltd.

C. D. Shepard

W. C. Smith

F. P. Sewell

▸ **W. C. Smith** and **Fred P. Sewell** were elected senior vice presidents of Delhi-Taylor Oil Corporation. Formerly vice presidents in charge of specific operations, they now have broader areas of responsibility. They will operate as group vice presidents coordinating the operations and policies of the operating divisions, consisting of exploration, production, manufacturing, marketing, petrochemical and research and development activities.

Smith was one of the original employees of Delhi Oil Corporation, predecessor of Delhi-Taylor, and was elected vice president of production in 1950. Sewell joined Taylor Refining Company, the other Delhi-Taylor forerunner, in 1933. He was elected vice president of manufacturing in 1952.

▸ **Arthur H. Denny** was named Canadian division gas superintendent by Pan American Petroleum Corporation. He moves to Calgary from Powell, Wyoming, where he had been superintendent of the Elk Basin gasoline plant since 1953.

▸ **Warren W. Homeyer** was appointed to the St. Louis technical service staff of Oakite Products, Inc. He has completed an intensive eight-week training program at Oakite's New York laboratories and in the field.

▸ **Darwin W. Ferguson** was elected president and director of Sun Oil Company, Ltd. Previously manager of the parent Sun Oil Company's Southeastern sales region at Jacksonville, Florida, he succeeds **Wilburn T. Askew** who returns to the parent company in Philadelphia in an executive capacity and will continue his association with Sun Oil Ltd. as a newly-elected vice president.

▸ **Dr. Virgil J. Berry Jr.,** formerly with Pan American Petroleum Corporation, Tulsa, has joined Sinclair Research Laboratories, Inc. as director of the petroleum engineering research division.

Dr. Stephen E. Szasz, technical director of petroleum engineering research, was promoted to departmental research associate. Dr. Szasz has directed Sinclair's work on new recovery methods, including thermal recovery techniques.

▸ **Donald Jensen** was appointed advertising and public relations manager of ACF Industries, Inc. He will supervise corporate public relations and advertising operations and coordinate similar activities of the company's six operating divisions. Since 1954 he has been responsible for financial, employee and plant city communications and advertising for Square D Electric Company.

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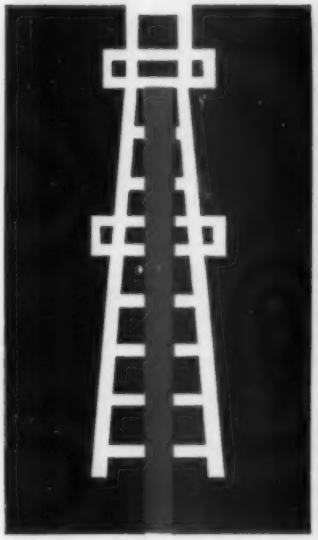

In the Petroleum Industry the IBM 1620 solves problems like these:

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Personals

▸ **Fred L. Hartley,** vice president of Union Oil Company of California, was elected a director and senior vice president and assumes executive responsibility for all marketing operations. **Arthur C. Stewart,** director and senior vice president, who had supervised marketing operations, now will be responsible for research, purchasing and the medical department and also will serve as director of Collier Carbon and Chemical Corporation, a Union Oil subsidiary.

C. Haines Finnell was appointed director of marketing; **F. K. Cadwell** was appointed director of export and refinery bulk sales; **Dr. W. E. Bradley** was named director of research succeeding Hartley; **Jerry Luboviski** was appointed manager of advertising and sales promotion; and **Earl M. Welty** was appointed director of public relations and in addition will be responsible for institutional advertising and governmental relations.

▸ **Porter Wharton Jr.** has joined Kerr-McGee Oil Industries, Inc., as director of public relations. For the past 7½ years, Wharton was associated with Miles Laboratories, Inc., in a similar capacity. He previously was with *The Elkhart Truth,* (Indiana) the city's daily newspaper.

GALVANIZE with Z.R.C.® to stop RUST!

Offshore drilling operators forget corrosion problems for four to five years when rigs are coated with Z.R.C.

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▸ **G. Curtis Mayes** was appointed joint interests manager for Mobil International Oil Company. He will advise on producing matters related to the company's joint interests in the Middle East. Mayes has been with the Mobil group of companies since 1941. Most recently he has been assistant to the joint interests manager, **Charles W. Boughton,** who has retired after 33 years of service with the company.

Clark A. Gruver was named assistant manager of Mobil Oil of Canada, Ltd., (Libyan Branch), an affiliate of Mobil International. The company headquarters is in Tripoli, Libya. He held a number of positions in both Venezuela and Colombia before becoming manager of services for Mobil Oil de Venezuela in 1958.

▸ **J. W. Hood,** former supervisor of community relations at the Ohio Oil Company, was appointed manager of the newly created public relations activities department, responsible for community relations matters and the editorial services function. **M. S. Hauser** is manager of Ohio Oil's public relations division.

▸ **C. D. Owens Jr.,** manager of industrial relations for Sinclair Oil & Gas Company, Tulsa, was transferred to New York City as assistant to **Millard E. Stone,** vice president and director of industrial relations for the Sinclair companies.

Bruce W. Gambill, industrial relations assistant, was appointed acting manager of industrial relations, succeeding Owens.

Formation of a separate safety department and the appointment of managers of the personnel and safety departments of Sinclair Oil & Gas were announced. **Hadley H. Myers,** personnel representative in charge of safety and training, was named manager of the new safety department; **John D. Sullivan,** personnel representative, was appointed manager of the personnel department. Safety has been a part of the personnel department's activities headed by **Henry W. Boggess** who now devotes full time as director of aviation.

▸ **Lewis A. Lapham** and **Albert L. Williams** were elected to the board of directors of the Socony Mobil Oil Company, Inc. Lapham is chairman of the executive committee of the Bankers Trust Company, New York and Williams is executive vice president and a director of International Business Machines Corp.

▸ **John A. Bruss** was appointed assistant treasurer of the Clark Oil & Refining Corporation. He was associated with Anchor Petroleum and in 1951 came to Clark as office manager.

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R. L. Minckler

Robert L. Minckler, senior vice president of the Mobil Oil Company, plans to retire from service with the company about the middle of the year. He was president of General Petroleum Corporation from 1948 until it was merged into its parent company January 1.

Minckler has agreed to remain with Mobil Oil until the new Mobil Oil organization plan is fully installed on the West Coast and to assist in its implementation. He joined General Petroleum in 1924 as an accountant. He was made assistant to the president ten years after joining the company. He was elected a director in 1941, a vice president in 1945, and executive vice president in 1947 and president in 1948.

William C. Lytle has retired as vice president of Atlas Powder Company. He has the unique distinction of having directed or managed at one time or another each of Atlas' major divisions. He has been handling special assignments for the president since last September.

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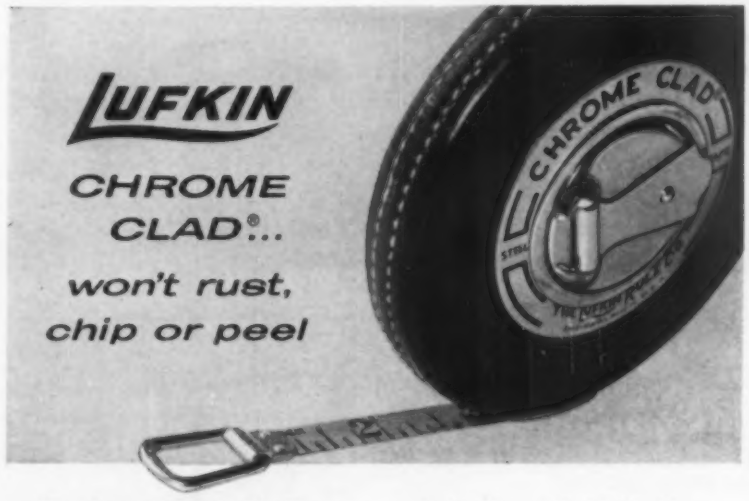

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Anchor lines are replaceable in the genuine-leather, hand-stitched case. Available with markings in feet, 10ths and 100ths.

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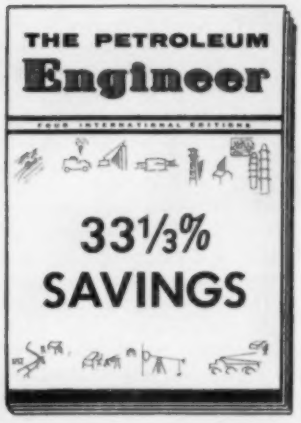

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During the past 18 months, circulation has increased at one of the fastest paces in our 30-year history. According to the latest available Publisher's Statements, Petroleum Engineer gained more new readers in the 12 months ending last June than any other A.B.C. audited publication serving the petroleum industry.

This increased number of subscribers means we can serve each one at a lower cost. We feel it only right to pass this savings on to our loyal friends who have made this growth possible.

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THE PETROLEUM ENGINEER • BOX 1589 • DALLAS, TEXAS

Personals

Jack Raglin, Houston, was promoted to assistant director of public affairs for Continental Oil Company. He formerly was administrative assistant to the president. In his new position, Raglin will continue to make his headquarters in Houston and will direct Continental's affairs program among employees. He joined Conoco's industrial relations department in Houston in 1951 as editor of employee publications and to director of the employee communications division in 1954.

Vance A. Knight, Houston, is promoted to assistant manager of Conoco's industrial relations department. Formerly administrative assistant in that department, he will continue to make his headquarters in Houston.

Francis Boyer, chairman of the board of Smith, Kline & French Laboratories, was elected to serve the unexpired term of Henning W. Prentis Jr., deceased, on the Atlantic Refining Company's board of directors.

Seventeen appointments of oil and gas industry executives to serve as executive reservists with the Department of Interior were announced by Secretary **Fred A. Seaton.** This group will carry out petroleum and gas functions in a national emergency.

Under delegation from the Office of Civil and Defense Mobilization, the Department of the Interior is charged with preparing plans to assure adequate fuel and power resources to meet emergency requirements. Personnel appointed for OCDM regions are:

Region 2 — Paul G. Benedum, Hiawatha Oil and Gas; **George C. Caine,** Tidewater; **A. S. Chamberlain,** Ashland Oil & Refining; **John P. Jones,** Standard Oil Company (Ohio); **Milan D. King,** Ohio Oil; **Robert H. Lynch,** Atlantic Pipe Line; **R. D. McGranahan,** Gulf Oil; and **Thomas G. Shirreffs,** Standard Oil (Ohio).

Region 3 — John C. Bolinger, East Tennessee Natural Gas; **Malcolm E. Grant** and **A. B. Hannah,** Plantation Pipe Line; **Charles M. Hunter,** Southern Natural Gas.

Region 7 — L. A. Cranson, Honolulu Oil; **David E. Day** and **Rollin Eckis,** Richfield Oil; **E. L. Hiatt,** Union Oil of California; and **Frank D. Lortscher,** Signal Oil and Gas.

J. G. Belcher and **J. O. Edwards** have been appointed assistant comptrollers of Standard Oil Company (New Jersey). Belcher has been with International Petroleum Co. Ltd. as an assistant comptroller. Edwards, with Jersey's domestic affiliate, Humble Oil & Refining Company, has been administrative services manager of the production and exploration departments.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Personals

▸ **Lewis P. Blanton** of Harlingen, Texas, was named chairman of the Federal Petroleum Board. He succeeds **Nelson Puett** who has been on temporary status as chairman, preliminary to retirement, after an extended period of service in that capacity.

▸ **J. C. FitzGerald** was appointed a member of the board of directors of Bataafse Internationale Petroleum Mij. N. V. **H. William Slotboom** has been appointed a member of the board of Shell Internationale Research Mij. N. V. In addition, FitzGerald and **D. de Bruyne** have each been appointed general attorney of Bataafse Petroleum Mij. N.V.

▸ Gulf Oil Corporation has announced the opening of a public relations office in Port Arthur, Texas, with **Ralph L. Lewis, Jr.** of the public relations staff in Houston, in charge.

Lewis joined the Port Arthur refinery in 1950 after receiving degrees in engineering and labor-management relations from the Pennsylvania State University. Upon completion of a management training program, he was assigned to the employee relations department and later served as the first editor of the refinery's employee publication *The Gulf Reporter*. In 1955 he was transferred to the company's public relations staff in Houston.

DEATHS

▸ **Robert E. Bering,** 64, organizer and president of the Signal Gasoline Company and Reserve Oil and Gas Company, and at the time of his death, president of Thermal Power Company, died January 6.

▸ **Lee M. Hogan,** 60, vice president of sales for The Standard Tube Company, died December 25, at his home in suburban Detroit, Michigan.

▸ **Dr. Beno Gutenberg,** 70, authority on geophysics and seismology, died at the Huntington Memorial Hospital in Pasadena, Calif. Jan. 25 after a short illness.

▸ **J. K. (Booty) Adams,** 59, died in Houston, Texas, January 4 after an illness of two weeks. He was manager of the land department for overseas operations of Tennessee Gas and Oil Company, a division of Tennessee Gas Transmission Company.

▸ **William O. Barnes,** 59, eastern division employee relations manager of Tidewater Oil Company, died January 5 in New York.

▸ **Austin C. Ross,** 66, retired and formerly vice president of Worthington Corporation, died January 8 after a long illness.

Look into Lonergan Gauges

Look into a Lonergan Maximon Gauge and you'll see the reasons why they are preferred where positive performance, accuracy and long life are required.

First the case. Here's the material to fit your needs—cast iron, cast brass, aluminum, or phenolic plastic. In addition, field conversion of the Maximon gauge to a Saf-T-Kase can be made by purchasing a low-cost Saf-T-Kit.

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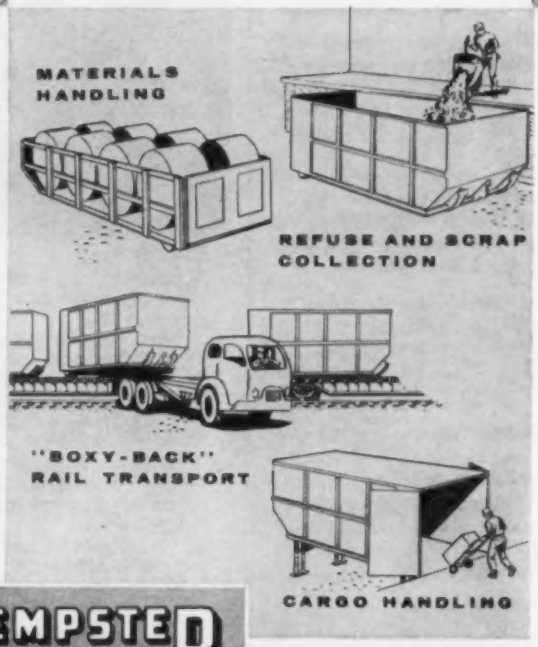

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by BILL ROAMER

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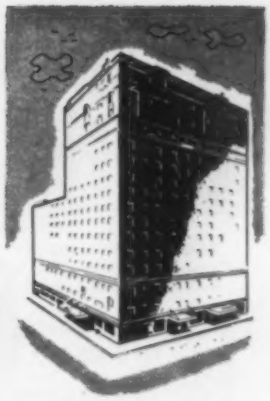
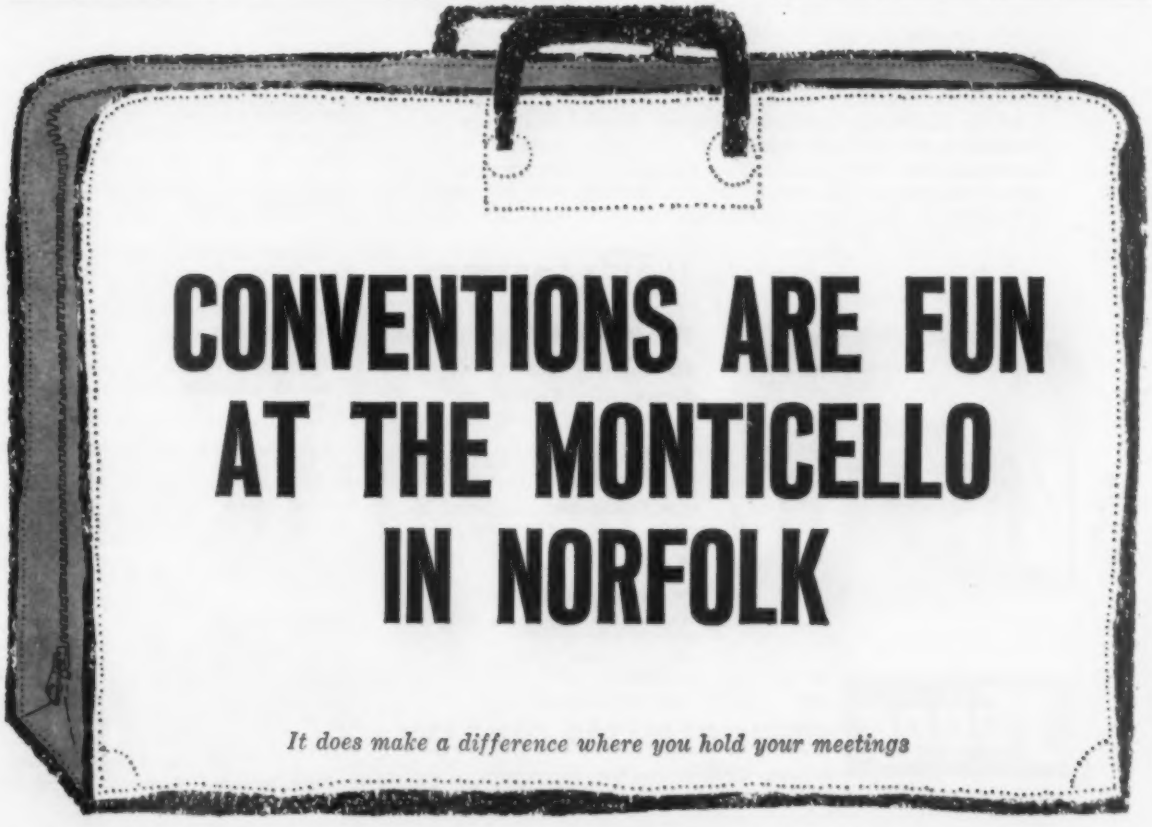


Houston's Hotel of Distinction

You'll like the extra luxuries and comforts which distinguish The Lamar... It's completely air-conditioned of course, with TV and radio in guest rooms. And food to please the most discriminating. Rates begin at $4.50. Garage Service.

GEORGE B. ADAMS
General Manager

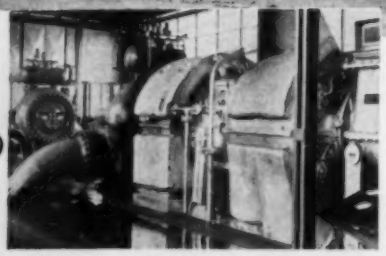
IN THE HEART OF THE THEATRE & SHOPPING DISTRICT



CONVENTIONS ARE FUN AT THE MONTICELLO IN NORFOLK

It does make a difference where you hold your meetings

15,000 hp gas turbine, centrifugal compressor station uses HC® units by Young to cool lube oil.



HC HORIZONTAL CORE

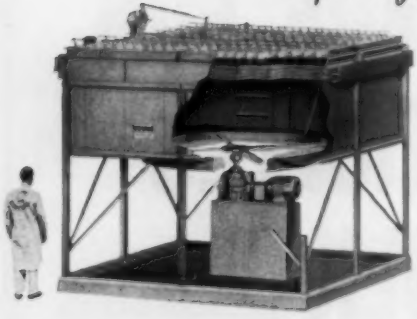
UNITS by *Young*... *the practical way*

to AIR COOL GAS TURBINES

To cool the lubricating oil of gas turbines at compressor stations and other gas and oil installations, HC® Horizontal Core Units by Young are ideal. Single and multiple in-line units are available for handling cooling or condensing of unlimited capacities. Low maintenance costs, limited piping, elimination of water and water pumping systems, and water treatment are economic factors for selection of these units. Cross winds or blanketed core areas do not effect the cooling efficiency of these horizontal core units. A wide selection of cores serve all type of applications for cooling and condensing requirements.

At the 15,000 h.p. gas turbine station (above) heat from the lubricating oil is dissipated to the atmosphere with oil-to-air horizontal core HC® Units. This dissipated heat amounts to approximately one Btu per minute per horsepower. *No water is required in the cooling operation.*

Specify **HC® UNITS**



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For Cooling and Temperature Control of:

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- WATER
- OIL

For Condensing:

- VAPORS
- STEAM

Write for Catalog 557
Dept. 580-C for more details

for all your atmospheric and fluid cooling requirements see

YOUNG RADIATOR COMPANY

General Offices: Racine, Wisconsin
Plants at: Racine, Wisconsin and Mattoon, Illinois

Laugh with Barney

We heard about a musician who worked all week on an arrangement — and then his wife didn't go out of town after all.

Conscience: the inner voice which warns us that someone may be looking.— H. L. Menchen.

Marriage: When a man gets hooked by his own line.

Honeymoon: Period between "I do" and "You'd better."

"You mean to say that you're engaged to five different boys at once?"
"Yeah, I can hardly wait until after Christmas to straighten things out."

The two lisping boys were sitting at the bar, holding hands. A man and a woman seated near them began arguing furiously.
Finally, the man strode away from the woman, approached the bartender and said angrily, "Give me my check and let me pay up and get out of here before I punch that dame right on the nose."
One swish boy nudged the other and simpered smugly, "You see! Those mixed marriages never work."

Two travelers, lost in a snow storm in the Alps, were found by a St. Bernard, equipped with the usual cask of brandy. The first to see the dog approach grasped his companion by the arm. "Look! at last . . . man's best friend."
"Yes, and look!" cried the other, "A dog carrying it."

This year's medal for fast-thinking husbands goes to the man whose wife discovered a bra in his suitcase when he returned from a business trip. He convinced her it was just a double-barreled sling shot.

He learned French from his girl friend in six easy liaisons.

You just can't beat football season. It's the only time of year you can walk down the street with a girl on one arm and a blanket on the other without anyone being suspicious.

First cannibal: "Am I late for dinner?"
Second cannibal: "Yes, everybody's eaten."

Rastus was dead. A wonderful funeral was in progress. The preacher talked at length of the good traits of the deceased, what an honest man he was, what a loving husband and kind father.
Finally, the widow whispered to one of her children, "Go up dere and take a look in de coffin and see if dat's yore pa."

Letter to Barney . . .

We recently received a card announcing the publication of a new handbook, "Accounting for Oil and Gas Producers." It is obviously a work of fiction because we all know that actually there's just no accounting for oil and gas producers.

Mr. AEC, Dallas, Texas

Editor's Note: No comment and/or 5th Amendment!

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

When you need DEPTH, REACH, SPEED put a UNIT on your job!

A 3/4-yd. UNIT Trench Hoe, owned by the River Construction Co., ditching for a 24" gas line.

On more and more pipeline jobs you'll find more and more UNITS handling the tough trenching operations. Pipeline contractors have found that UNIT dependability, versatility and exclusive features give them big production, lower operating and maintenance costs, and lower cost per mile of trench.

Long-reaching UNIT Trench Hoes mean less frequent moves and casting of spoil well away from the trench. Digging depths range down to 21′ 3″. UNIT'S boom and bucket design assure full bucket loads without spillage, and the simple, direct power application means full power at the dipper teeth for cutting through the toughest soil conditions. Booming up and down, and swinging are fast . . . paying off in more ditch per hour.

UNIT Hoes are available in ½, ⅝ and ¾ Yd. crawler and truck-mounted models, all fully convertible to shovel, dragline, clamshell and crane booms for any phase of pipeline construction or refinery maintenance. See your nearby UNIT dealer or send for complete details *today*.

☆ **ONE-PIECE CAST GEAR CASE** thoroughly seals out dirt and moisture . . . keeps all gears, shafts, and bearings in a constant oil bath.

☆ **STRAIGHT-IN-LINE ENGINE MOUNTING** maintains perfect alignment for the life of the machine. There's no separate right angle gear reducer . . . no wasted horsepower.

☆ **DISC CLUTCHES** insure smoother operation . . . adjust easily for uniform pressure and minimum wear.

☆ **WORM DRIVE** transmits power evenly and steadily . . . reduction from engine to main machinery is only one simple step.

☆ **FULL VISION CAB** gives your operator 360° visibility . . . lets him do a better job for you with complete safety for all personnel.

UNIT
CRANE & SHOVEL CORP.
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Unit Crane & Shovel Corp.
6603 W. Burnham St., Milwaukee 19, Wis.

Gentlemen:
Send full information on UNIT Trench Hoes in the following sizes:

- ○ 1/2-yd.
- ○ 5/8-yd.
- ○ 3/4-yd.

Name _____ Title _____
Company _____
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City _____ Zone _____ State _____

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

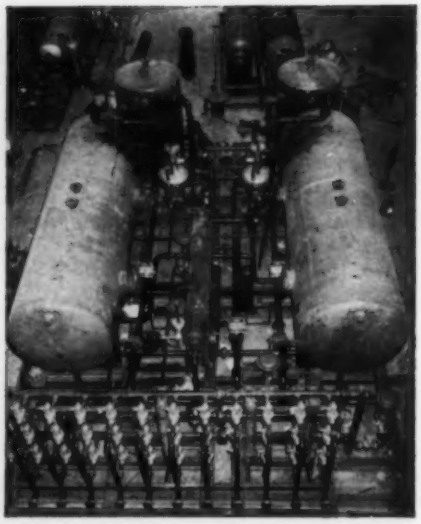
NATIONAL® automatic packaged units

WHY BUY NATIONAL PACKAGED PRODUCTION EQUIPMENT UNITS . . .

- **Made in shops having the most complete and modern facilities available**
- **Safe-tested under strictest codes**
- **Properly engineered for accessibility**
- **Lower cost due to National know-how**

National Packaged Units assure delivery at the location of COMPLETE units . . . skidding, piping, insulation, instrumentation, coatings and accessories. "Packaging" by National eliminates the purchase and assembly of hundreds of items; eliminates costly waiting time and transportation charges rounding up missing materials and fittings.

Through good engineering, design and arrangement, the connection crew in the field is concerned only with the major product lines to and from NATIONAL PACKAGED UNITS.



National can handle all your production problems "from the wellhead to the consumer."

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Modern facilities include sand blasting and coating.

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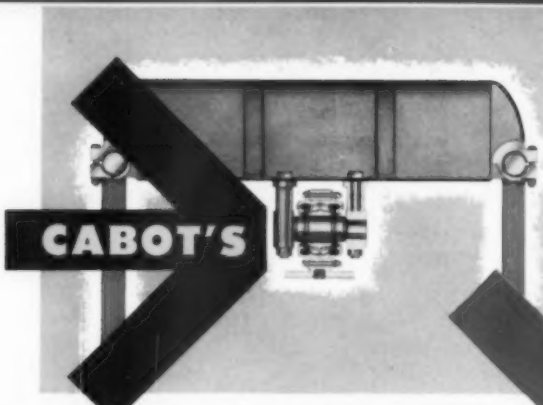
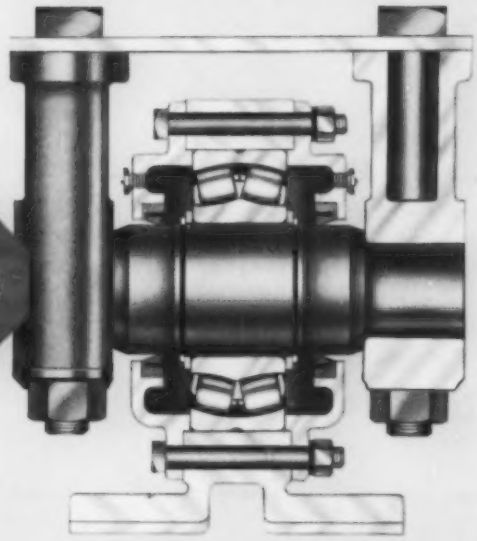


CABOT'S

NEW EQUALIGN BEARING

PUMPING UNITS
THAT STAY YOUNG LONGER



CALL YOUR J&L MAN

Our engineers advise us that our new Equalign Pumping Units have many improvements as well as geometric design for equal torque factors.

We advise you to see this new series at your nearest J & L Supply store, for here are units engineered for long, trouble-free life — backed by Cabot's 24-hour field service . . . another reason why it pays to get the Cabot habit.

New Equalign Bearing

The Cabot Equalign Bearing contains a heavy duty spherical roller bearing which gives universal equalization. Grease and relief fittings are arranged so that grease is forced through the bearing with each greasing. The pumping units equipped with this type bearing are designed for equal torque factors. Pin-end pitmans are used.

OIL FIELD PUMPING EQUIPMENT
CABOT SHOPS, INC.
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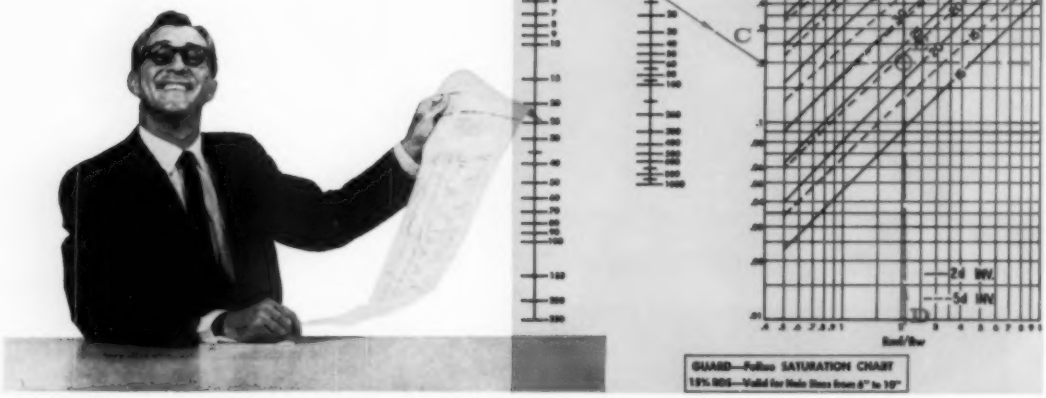
FRANKS DIVISION OF CABOT

Reading A Welex Log Is A Cinch!



That's right — it's as easy as drawing a straight line.

With Welex's new simplified interpretation charts, or "pigtails," printed right on the log where they are always convenient, you can read POROSITY directly off the log and calculate FLUID SATURATION in seconds. No complicated computations are needed.

To use the Guard-FoRxo "pigtail" above to figure FLUID SATURATION, follow these simple steps. In this example, values read directly off the log in the zone of interest were: FoRxo 2 Ohms; Guard 10 Ohms; SP (self potential) —22 millivolts.

A. Pinpoint the FoRxo value on the FoRxo scale.

B. Pinpoint the Guard value on the Guard scale.

C. Connect points "A" and "B" with a straight line and extend it to intersect the side of the water saturation chart at point "C". Draw a horizontal line from point "C" across the chart.

D. Pinpoint the Rmf/Rw value (if known from Rw data in the area) on the Rmf/Rw scale at the bottom of the chart and raise a vertical line to intersect the horizontal line at point "E". (If Rw data is not available, an alternate method is to pinpoint the SP value (—22 millivolts) on the SP scale at the top and drop a vertical line.)

E. Read the percent of FLUID SATURATION at the intersection of the two lines.

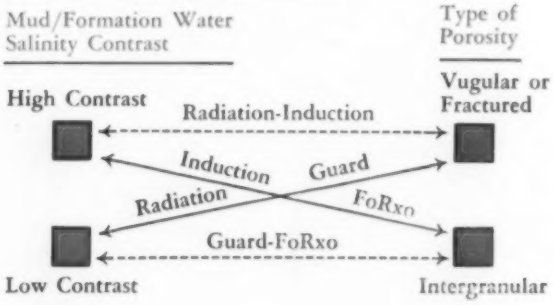
The answer in this illustration is 22 percent.

And just as simple as the "pigtail" is the actual selection of the right logging service for your well, thanks to Welex's new simplified logging program. Based on type of porosity and the salinity contrast between drilling mud and formation water, the diagram here shows how simple it is to choose the right logs without running any excess logs.

For example, the diagram shows that if the salinity contrast is low and the porosity is intergranular, the best log for your well is Welex's Guard-FoRxo. If the porosity is the same type and the salinity contrast is high, the best choice is the Induction FoRxo.

Fast, accurate and simple — that's Welex's new logging program. The Guard-FoRxo, the Induction-FoRxo, Radiation-Guard and Radiation-Induction, each with its own easy-to-use "pigtail," give fast, accurate answers in more than 90 percent of today's wells.

For the right logging answer for your well, call your nearest Welex representative.



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Of Things To Come . . . In Oil

DON'T GIVE UP SO-CALLED "EXOTIC" DRILLING TECHNIQUES. Hammer drill developed by Pan American Production and Mission Manufacturing has proved successful in numerous field tests in West Texas using mud as power fluid. Research continues on using air and gas as possible power fluids to extend application. Also, further study goes on with the turbodrill. Bit developments and improved hydraulics will put this Russian idea back into the running. The sonic drill, under research and development by Borg-Warner in cooperation with Shell Oil in California for the past five years and then dropped, is now under study by United Aircraft's Hamilton Standard division. If it still looks good, UA might make contract agreement with Bodine, sonic drill inventor.

SHORTAGE OF PETROLEUM ENGINEERS will return unless college freshman enrollment increases substantially, and soon. After two or three years of a virtual excess of engineers, employment opportunities "improved markedly" last year, according to Dr. George H. Fancher, chairman of petroleum engineering department at the University of Texas. He anticipates "a real shortage of petroleum engineers from the University in the next year or two" because of lower freshman and sophomore enrollment, and this situation is indicative of the nation-wide problem in other universities.

OKLAHOMA'S FIRST COMMERCIAL FIREFLOOD will recover 70 percent of oil in place, according to Thermal Recovery Corp., operator of the project. Located in southern Oklahoma, the 245-acre leasehold involved in the in-situ recovery venture will be developed by drilling on 7½-acre inverted five-spot patterns. Combustion will be initiated in the Lower Cisco sand of the Pennsylvanian, at a depth of about 850 ft. Fuel gas for air compressors will come from the Upper Cisco.

WELL LOGGER'S DREAM TOOL may be incorporated in a new instrument announced by Stancal and Borg-Warner Corp. and called the nuclear magnetism log. Developers claim the tool will give direct information on location and nature of underground fluids, locate productive zones previously undetected, possibly distinguish between oil and water, and even give basis for calculating oil potential of productive zones. Tool has been field-tested in several states and commercial models are being developed.

measure your penetration in feet

with WESTERN'S versatile

SANDRIL

hydraulic perforating process

For these primary applications . . .

- Standard perforating patterns
- Special hole patterns—including Fracture Initiation pattern—you set the specifications
- Casing and tubing cutting
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- Permanent-type completions
- Natural completions
- Dual tubing string completions
- In slim holes to largest diameter casing
- Open hole completions

With these advantages . . .

- Controlled penetration in casing and open hole
- Controlled entry-hole size
- Shoot and treat on same set-up
- Shoot and test on same set-up
- No debris—absolutely clean hole
- No compaction of formation in excavation
- No cement damage
- No shock to casing
- No burring of perforations

For full details on Sandril hydraulic perforating process and its many applications in your wells, call your Western Engineer.

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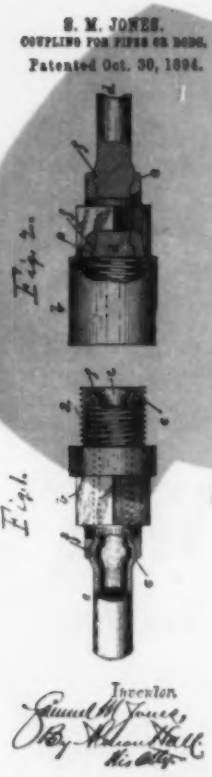
WESTERN Engineered WELL SERVICES

JONES

FIRST IN 1894...



"Be it known that I, Samuel M. Jones, a citizen of the United States, residing at Toledo, Lucas County, Ohio, have invented certain new and useful Improvements in Couplings for Pipes or Rods, of which the following is a specification."

So reads the opening paragraph of Patent No. 528,168 granted October 30, 1894 . . . this was the beginning of JONES specialization...

FIRST TODAY...

Now, precision is the word for Jones couplings and sub-couplings. Made in two finishes..."Soft" and "Hardened and Ground", Jones couplings are finished and quality-controlled to API specifications. For the very finest in low cost oil recovery, continue to use Jones sucker rods and couplings...the products of recognized specialists.

...because we're Sucker Rod Specialists!

There are four JONES JOB-ENGINEERED SUCKER RODS... a type for every pumping need!

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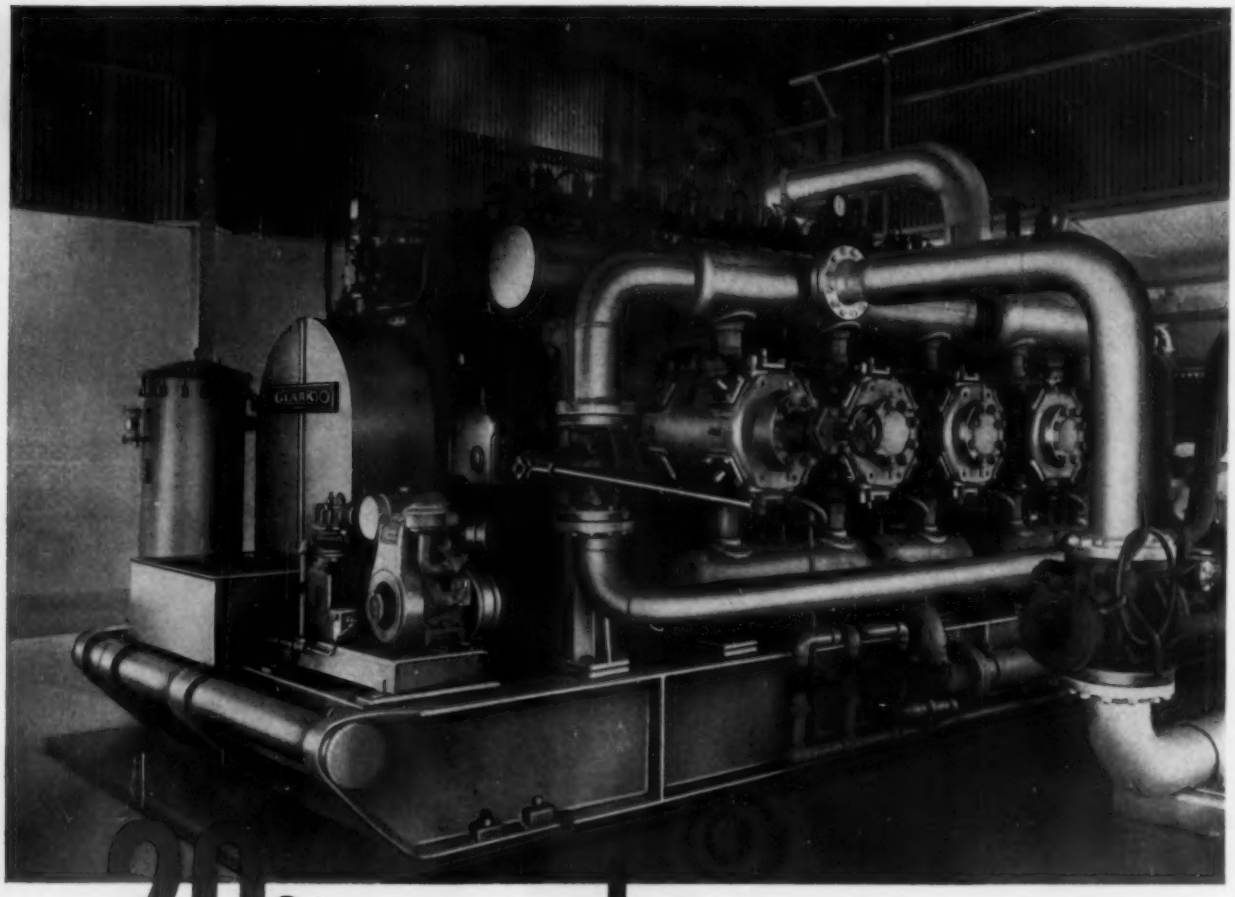
IDECO, One of the Dresser Industries, Dallas—New York

Franklin Supply Company, Export Division, Inc., New York



20% more horsepower

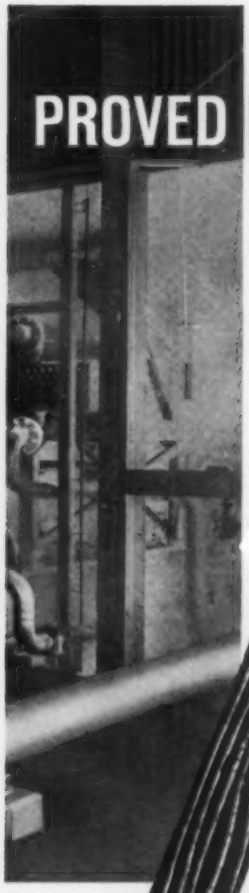
without additional power end loading achieved in CLARK turbocharged TMB compressor.

Maximum horsepower in minimum space... that's the Clark TMB packaged field compressor. A turbocharged version of the widely used HMB, the TMB, has earned a reputation as a willing, rugged, "take-charge" type of unit that owners admire and operators love. It's not fussy about the fuel it burns and never gets cranky or unruly just when you need it most — when the going is tough.

Although horsepower available for compression in the TMB is increased by 20%, no additional load is imposed upon the power end. This paradox of "more for less" is made possible by turbocharging. At rated condition the scavenging load is completely removed from the crankshaft and transferred to the turbocharger. Scavenging cylinders "work" only at start up and light loads... at all other conditions they are bypassed and float in the system.

We have put all the facts on these 400, 525 and 660 bhp compressor units into a new picture-packed brochure. Write today for your copy of Bulletin No. 157 or call your nearest Clark office for an on-the-spot report.

PROVED in the Permian Basin...



PERFORMANCE DATA

Permian Basin Pipeline Co. purchased the first TMB-10 manufactured by Clark and installed it in Lea County, New Mexico. After 18 months of highly satisfactory operation, here is a report on this first unit:

SERVICE PERFORMED - Field gathering station located at the wellhead.

ALTITUDE - 4100 feet. (Turbocharging compensates for hp loss due to elevation derating.)

PRESSURES - Suction---50# to 100#; Discharge---450# to 500#.

STAGES - Two-stage operation. (Can be converted to single-stage operation.)

SCAVENGING CYLINDERS - Four. One bypass cylinder.

VOLUME - Rated capacity, 4,390,000 to 5,820,000 CFD.

LOAD VARIATION - 70% to 125%.

FUEL - Untreated sour gas containing 30 grains H_2S direct from well. 1120 btu; 1.5% CO_2. (TMB can burn wide variety of field gases without detonation.)

AMBIENT TEMPERATURES - 12° to 106°.

DIRT IN GAS - Little, but considerable oil.

REDUCED SPEEDS - Operated as low as 480 rpm. with constant torque.

UNATTENDED OPERATION - Gets little attention. Unit checked only three times weekly because of protective shutdown devices.

Downtime: Negligible.

Conclusion:

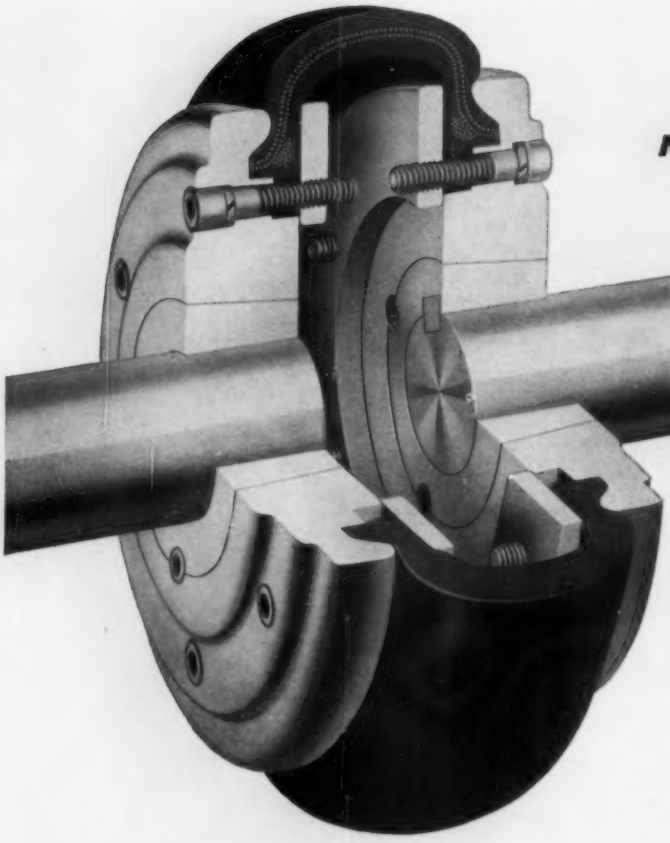
TMB thoroughly proved on the job. Has great potential for variety of field applications!

CLARK

ONE OF THE DRESSER INDUSTRIES

CLARK BROS. CO. OLEAN, N.Y.

ENGINES • COMPRESSORS • GAS TURBINES



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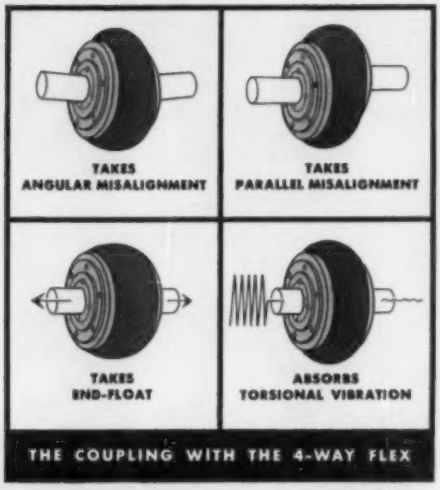
DIFFERENT!



DODGE

Para-flex

FLEXIBLE CUSHION COUPLING

THIS coupling "swallows up" shaft misplacements. It automatically compensates for end-float, parallel misalignment, angular misalignment *or any combination of all three.* Moreover, it cushions the stresses of shock loads. And it absorbs torsional vibration—reducing noise and protecting machinery from vibration's destructive forces.

Here is a new type of performance—made possible by the development of a tire-like flexing element. Synthetic tension members, bonded together in rubber, give this element the stamina and dependability of modern, high-speed, high-load, shock-absorbing truck tires—and the ability to respond magically to all manner of changing shaft conditions.

Para-flex takes minimum space on the shaft. Mounting is simplified through the use of standard Taper-Lock bushings—no reboring, no machining. Safety is promoted by flush design; there are no protruding parts. No lubrication is required, no periodic inspection. And since the flexible member is molded with a transverse split, it can be replaced *without moving either the driver or driven machine.*

Para-flex Couplings are stocked by Dodge Distributors in popular transmission sizes. They are available from factory stock in capacities up to 2000 hp at 1080 rpm. Call your distributor for a coupling to *make your own test.* You'll witness something revolutionary!

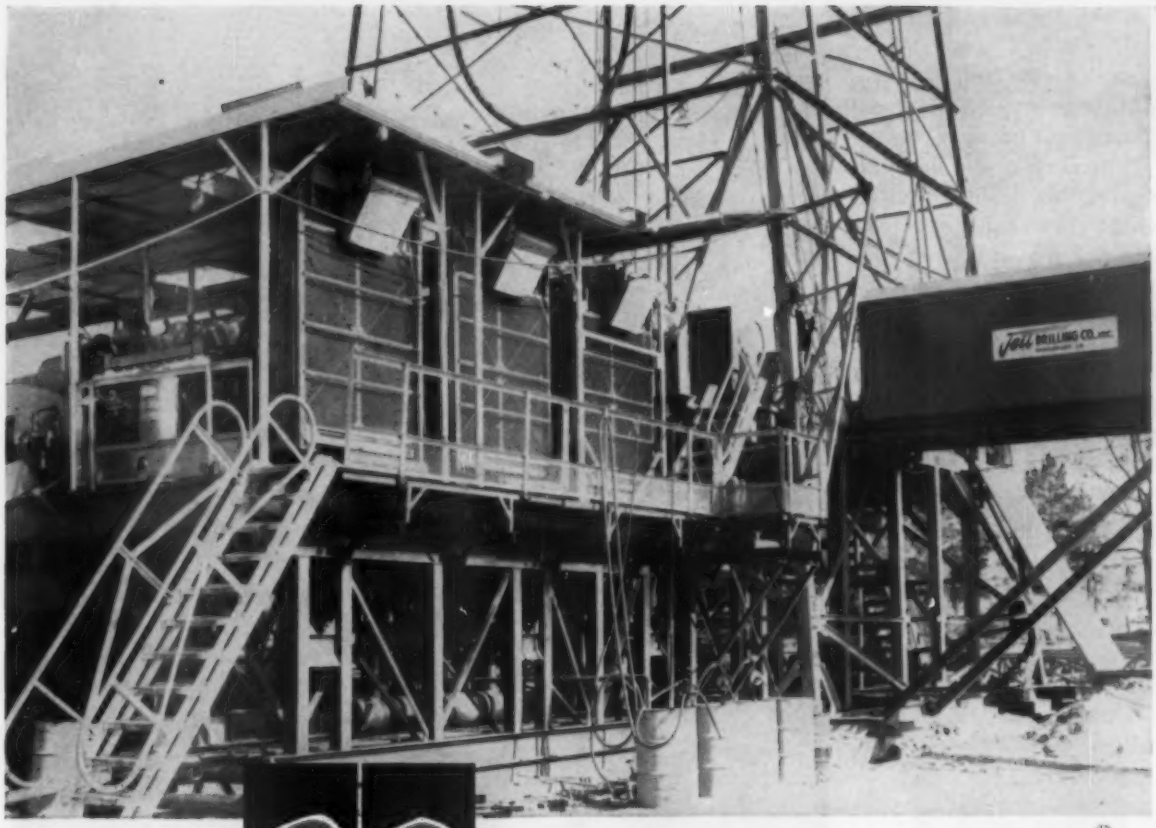
DODGE MANUFACTURING CORPORATION, 7900 Union, Mishawaka, Ind.

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

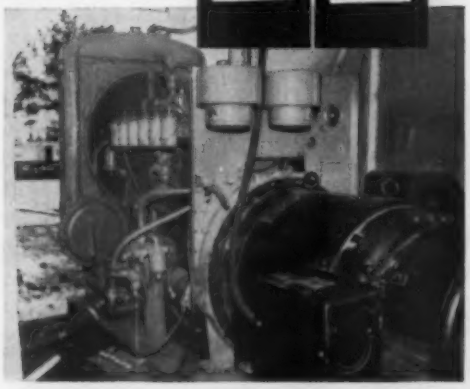
FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD



22 WAUKESHAS
POWER 10 DRILLING RIGS

George H. Jett, of the Jett Drilling Co., Inc., Shreveport, La., relies on Waukesha power for his extensive drilling operations in Louisiana, Mississippi, and Alabama, because he's sold on Waukesha's rugged, dependable and economical long life engine operation.

Pictured above is the Jett Rig #114, powered by three Model VLROBU Waukesha Power Units, operating on natural gas. Inset shows a Waukesha "Long Life" Model 145-GZB gas unit, powering a 50 KW generating set, to supply electric power for the rig.



On nine other drilling rigs, Mr. Jett is using ten LRDBC (Diesel); six LRZB (gas); two LRORB (gas); and one NKDBSU (Diesel). With the skid arrangement and the same crankshaft center line heights on the LRDBC, LRZB, and LROR models, the Jett crews can easily change over from gas to Diesel operation in a few hours.

Waukesha can supply your oil field power needs, too. SEND FOR BULLETINS

464

WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN / New York • Tulsa • Los Angeles
Factories: Waukesha, Wisconsin and Clinton, Iowa

Lower a McCullough Chemical Tubing Cutter to the desired depth. Push a button. Before you can snap your fingers, your tubing is cut.

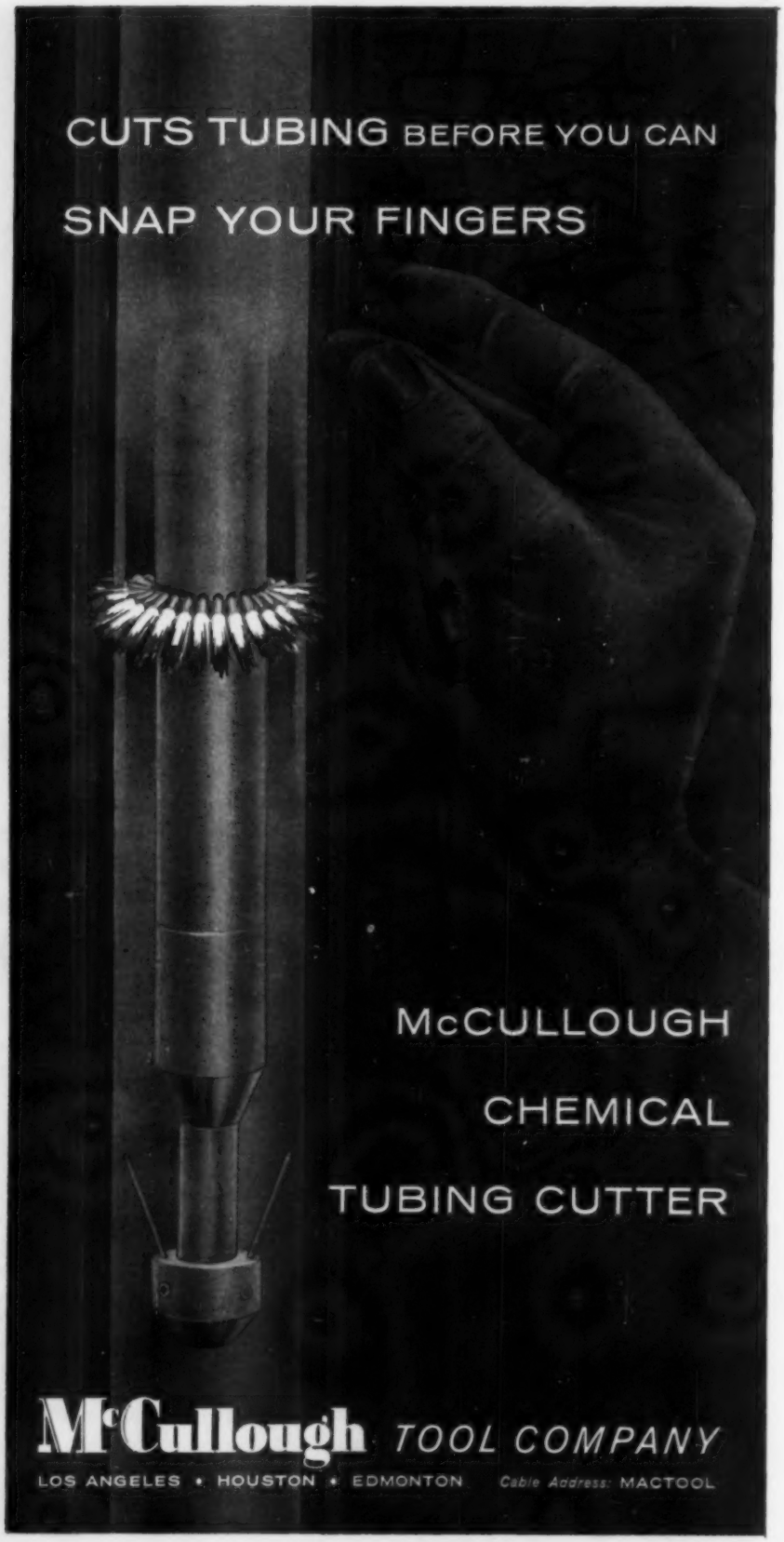
This electric wire line tool applies the enormous power of halogen fluorides to cut tubing as easily as a knife cuts through hot butter — and it's a smooth, flare-free cut — no burrs nor distortions on either the OD or ID of the tubing.

Cutting action is closely controlled. The outside casing

or tubing will not be damaged. Entire operation is 100% junk-free, as no part of the cutter is expendable.

Compared to mechanical methods, you will make significant savings in valuable rigtime when you use the McCullough Chemical Tubing Cutter. Available for 2" and 2½" tubing at all McCullough Service locations.

Additional Service Representative: Houston Oil Field Material Company, Inc.



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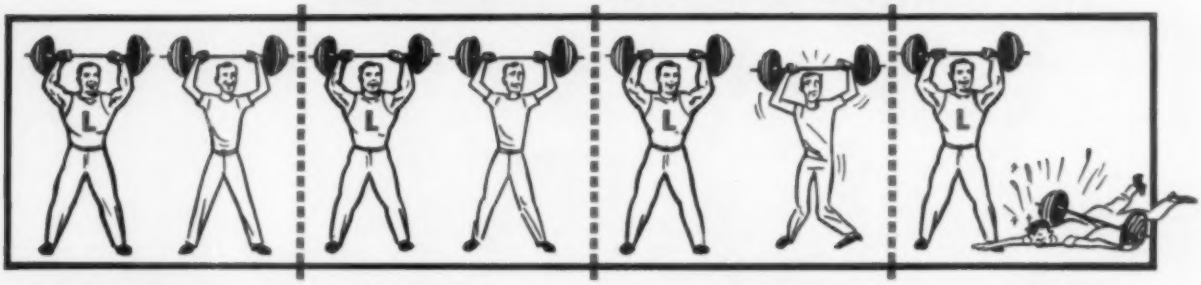
Sure! LUFKIN UNITS ARE HEAVIER!

"H--- for STOUT"

has been the LUFKIN motto from the very beginning . . . a policy that has given LUFKIN units a reputation for UNSURPASSED ENDURANCE and PERFORMANCE . . .

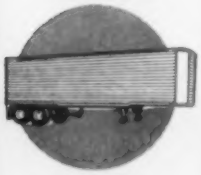


GOOD ENOUGH | WE WONDER . . . | . . . LATER | WUPS

You Can Relax When Your Lease Is **LUFKIN EQUIPPED**

PUMPING UNITS

GAS ENGINES



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Lufkin equipment in Canada is handled by
THE LUFKIN MACHINE CO., LTD., 9950 65th Avenue, Edmonton, Alberta, Canada, Regina, Saskatchewan, Canada

UNION

The *UNIQUE Wire Rope Organization

**Single in Kind or Excellence*

Customers can be credited for Union's outstanding position.

Why? Simply because in large numbers they accepted Union's standing invitation to share their wire rope and sling problems with Union's technical, research and engineering staff.

In meeting these challenges, Union has compiled an outstanding record in wire rope advancements. Some 1600 standard wire rope constructions are in day-to-day production under statistical quality controls which insure "the ultimate low cost rope." This means quality so good that it costs less in the long run.

In searching for better answers to wire rope and sling problems for customers, Union engineers developed the famous family of Tuffy wire ropes and slings.

Rotary drilling called for a special wire rope. There was none until after Union engineers spent many months in the field studying the operation of standard constructions on rotary rigs. Back in the Union laboratories, they researched many constructions to find the special one that performed better, gave longer service life, less down-time and greater safety in rotary drilling. Tuffy Rotary Line proved its excellence and in the proving Union Wire Rope engineers developed the rope saving cut-off procedure now widely followed in rotary drilling.

Tuffy® Rotary Drilling Line

Tuffy Rotary Drilling Lines Are "Ton-Mile Engineered"

Tuffy Standard Rotary Line is "ton-mile" engineered for standard rigs and large jackknife rotary rigs. Tuffy Jackknife Rotary Line is for drilling to 6,000 feet with smaller jackknife rigs.

Union Wire Rope Covers All the Bases In the Oil Industry

Worthy companions to Tuffy Rotary Line are Union Standard wire ropes for servicing wells. There are 5 constructions for rod and tube pulling and standard constructions of rod hanger line, sand and sand pump line, cable tool drilling line and winch line.

Big Paul, The King of Spades, world's largest electric power shovel. In taking a 105 ton bite (2 rail carloads) it imposes a maximum bail pull upon the wire ropes of 550,000 lbs. One-half mile of wire rope is required in its operation by the Peabody Coal Company at its modern River King Mine, Freeburg, Ill.

Wherever you are in the oil world, Union standard wire ropes and Tuffy Rotary lines are quickly available from leading oil field supply stores. Get service you can rely on. Get the Ultimate low cost wire rope.

Ton Mile Indicator

This slide chart provides you a quick, easy method of figuring ton-miles in following the cut-off practice originally developed by Union engineers. Write Union Wire Rope Corporation, 2106 Manchester Ave., Kansas City 26, Mo.

1-0

Tuffy Wire Rope Tips

on Safe Use of Wire Rope and Slings

On the Blink from a Kink

Mishandling of rope caused this open kink. Avoid kinks by proper winding on the drum. Never pull a loop smaller. Enlarge it, then straighten out the rope.

Overloaded - Soon Exploded

The rated capacity of a wire rope is based on breaking strength divided by the load factor for particular type of service. Grade of steel, type of construction and size of rope determine tensile strength. Unless rope is properly related to loads, costly and dangerous early failures are likely to occur.

Mangled in a Wedge Socket

Here's a result of improper socketing, caused by poorly designed or worn-out wedge socket. Can be costly and hazardous!

Victim of the "Bends"

Excessive bending of rope speeds up wear. General rule: use more flexible ropes as bending stresses increase (with decrease in tread diameter of sheave or drum). If sheaves are too small, early rope failure is certain.

Would you like a copy of a booklet in which more than a score of Tuffy Tips like those above are reproduced. If so, write Union Wire Rope Corporation, 2106 Manchester Ave., Kansas City 26, Missouri.

UNION Wire Rope

Subsidiary of **ARMCO STEEL CORPORATION**

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company
Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Southwest Steel Products

Year After Year...

PGAC RESEARCH

breaks through more of the barriers to OIL

1947-48	Atlas Bullet Guns and Jet Introduction
1949-50	Simultaneous N/N Nuclear Logging
1951-52	Four-Resistivity-Curve Electrical Log
1953	Quantitative Evaluation of Porosity
1954	Mighty Mouse® Tubing Perforators
1955	Simultaneous 5-Curve Electrical Log
1956	Super Mighty Mouse® Tubing Guns Absolute Calibration for Nuclear Logs
1957	Strata-Test Fluid Sampler/Tester PH-125 Neutron/Neutron Nuclear Log
1958	INDUCTION-ELECTRICAL LOG LATEROLOG AND MICROLATEROLOG CONTINUOUS DIPMETER SURVEY

1959 SPECTRAL LOG

for the detection of chlorine

PGAC-601

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Pan Geo Atlas Corp.

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PGAC's SUBSIDIARY COMPANIES— CANADA — Perforating Guns of Canada, Ltd. VENEZUELA and BOLIVIA — Servicios Tecnicos Atlas, C.A.
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GUIBERSON'S FULL RANGE
of High and Low Pressure, Quick Change
UNIONS

1,000 lb. test
2,000 lb. test

4,000 lb. test
6,000 lb. test
10,000 lb. test
15,000 lb. test

Quick and easy to make or break, Guiberson's Unions are ideal for a multitude of uses... give a positive, leakproof seal, with minimum upkeep. Guiberson's low pressure unions 1" through 10" sizes have metal to metal seats, feature a convenient 3-lug wing nut.

High pressure unions are made in 1" through 4" sizes. 6,000 lb., 10,000 lb. and 15,000 lb. unions incorporate the pressure-molded Seal-O-Matic Ring. All high pressure unions are forged steel.

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THE
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ESTABLISHED 1919
DALLAS, TEXAS
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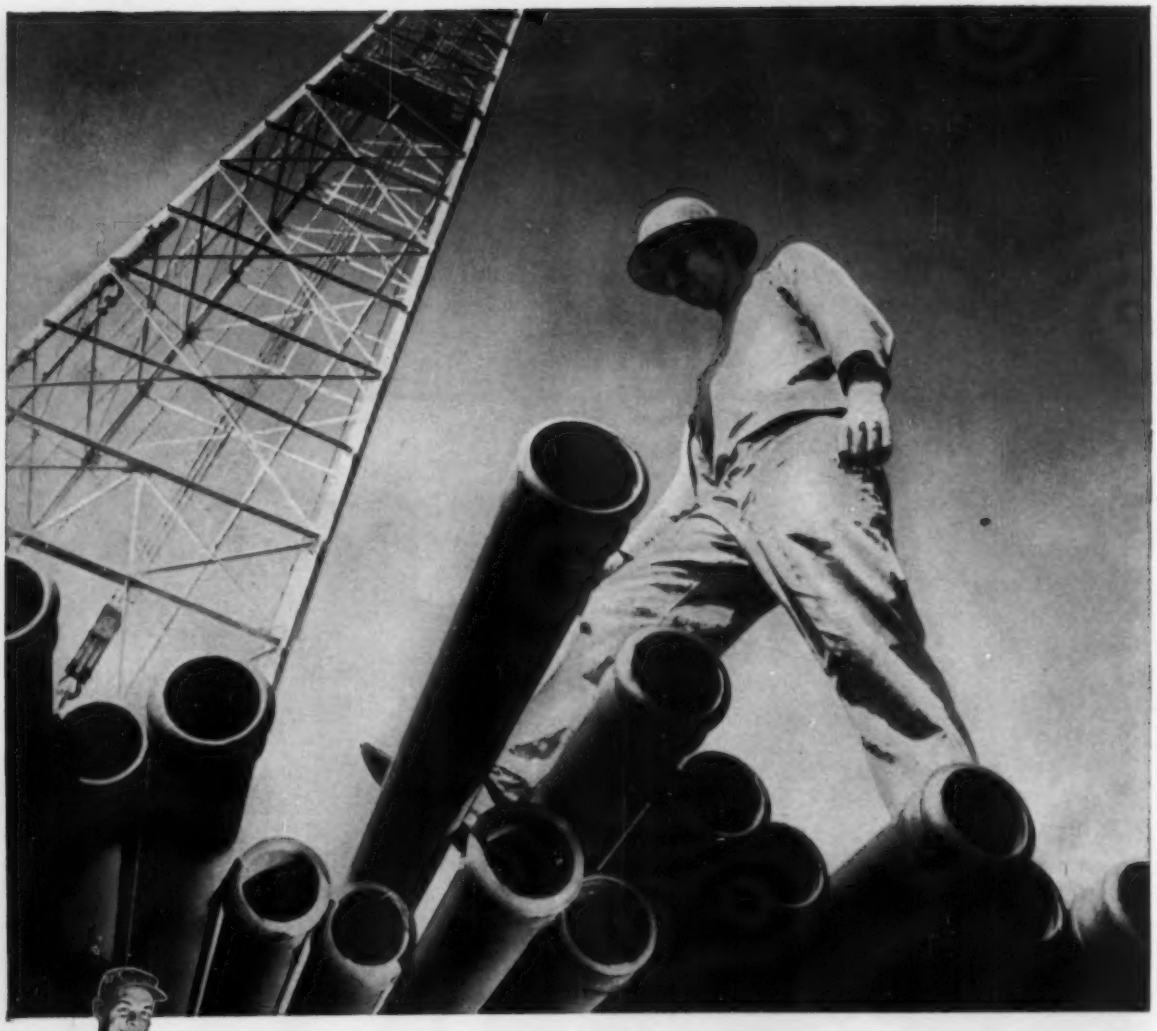
Sold by
Oil Field Supply Stores
Everywhere



What's behind the demand for

CF&I Seamless Casing and Tubing?

Look at the company and what it represents. For the petroleum industry, the Image of CF&I stands for a high grade of seamless casing and tubing. The steel used is made by CF&I. Manufacturing facilities and equipment are among the most up-to-date in the industry. CF&I's production techniques feature unusually exact quality controls. For special technical problems, CF&I offers expert engineering services.

CF&I's mill is ideally situated in Pueblo, Colorado. Around it, a thousand miles in every direction, stretch the rich oil fields of North America. This location facilitates rapid delivery, either by rail or truck, even to the most remote sites. All CF&I Seamless Casing and Tubing is made to API specifications. It's available in sizes 2⅜" to 9⅝" O.D. Get full details from a CF&I Sales Representative or your local distributor.

7924

CF&I STEEL **SEAMLESS** *casing and tubing* API

THE COLORADO FUEL AND IRON CORPORATION • DENVER, COLORADO

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Shrinking Dollars *Mean Shrinking Profits*

ALWAYS A FULL DOLLAR'S VALUE FROM AJAX

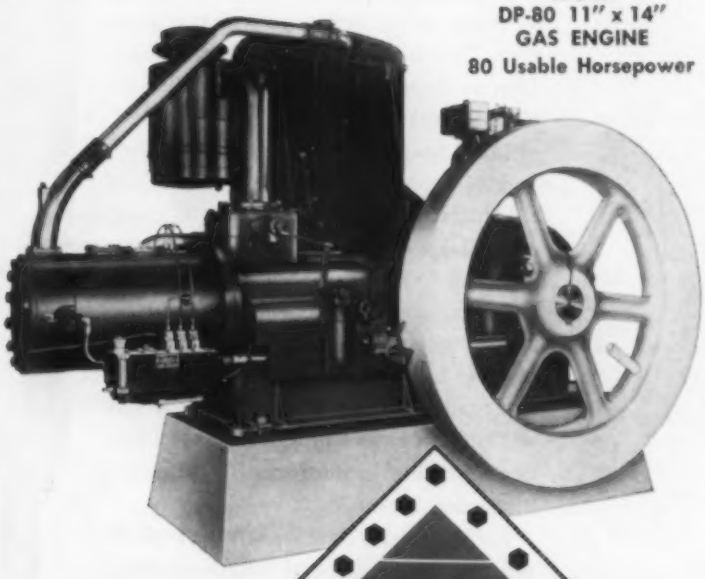
Equipment investment costs are more critical today than ever before.

Awareness of this fact is the reason for the addition to the famous craftsmanship quality line of Ajax Engines of this new intermediate 80 Usable horsepower unit.

With Ajax you don't have to buy more than you need in horsepower to still have a safety reserve and economical operation.

Simple but massive construction for easy low cost maintenance and long life — rugged special clutch for limited attendance — thermo-syphon cooling — are just a few of the full dollar value Ajax features . . .

Introducing the NEW DP-80 11" x 14" GAS ENGINE 80 Usable Horsepower



AJAX

AJAX GAS AND OIL ENGINES

AJAX IRON WORKS CORRY, PENNSYLVANIA

OIL FIELD DISTRIBUTORS: The National Supply Co., Pittsburgh, Pa.
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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

FOR PRACTICAL DUAL STRING COMPLETIONS

COMPARE THE SIMPLICITY, convenience and dependability of Baker Snap-Set Dual Packers with packers that depend on elaborate seals, valves and other intricate mechanisms.

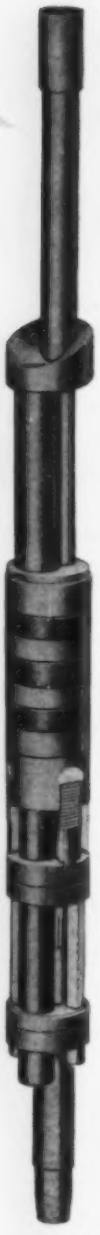
Baker Snap-Set Dual Packers are easier to set than the simplest of hook-wall packers—just set down a slight amount of weight on the tubing to pack-off, simply pickup to release. They can be set and released as many times as desired without rotation, ball dropping or pressuring.

Baker Snap-Set Dual Packers offer full-opening through both sides for two strings of 2⅜" tubing when run in the popular 7" casing.

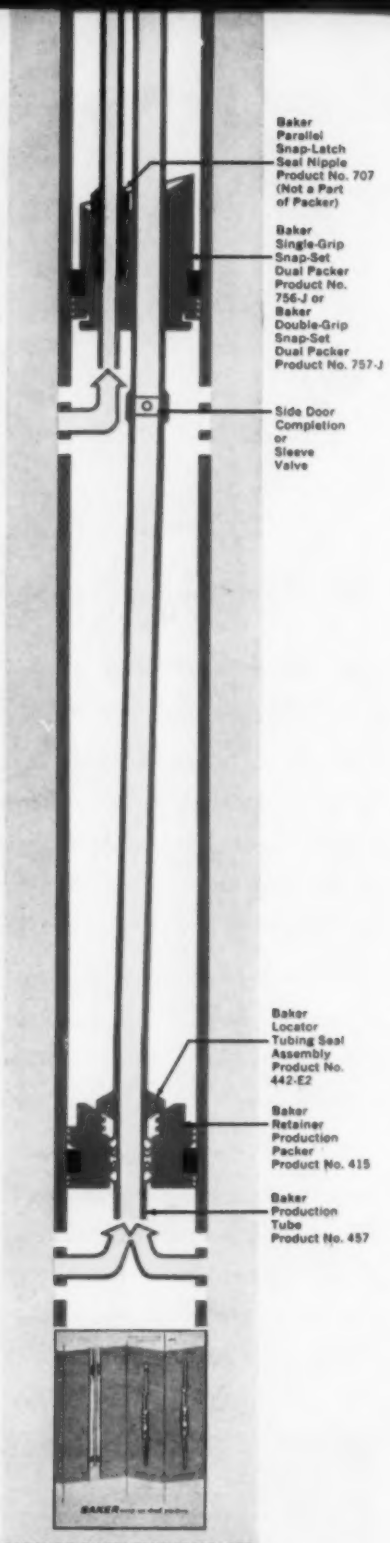
The Baker Model "J" Snap-Set Dual Packer is the ideal upper packer in a practical two-packer parallel string hookup, such as shown in the schematic at right. This hookup allows zones to be unloaded and washed after the well head is flanged up. Note that the vital separation of zones is provided by the reliable, time-tested, high-performance Baker Retainer Production Packer.

Baker Snap-Set Dual Packers are available with hydraulic button-type hold-downs where high differential pressures are to be encountered from below.

Ask for Catalog Supplement No. 357, which completely describes these packers and their use in selective-multiple zone completions, in addition to several popular dual-zone hookups.



BAKER SNAP-SET DUAL PACKERS Shown is the Model "J", Single-Grip, Product No. 756-J.


Baker Parallel Snap-Latch Seal Nipple Product No. 707 (Not a Part of Packer)
Baker Single-Grip Snap-Set Dual Packer Product No. 756-J or Baker Double-Grip Snap-Set Dual Packer Product No. 757-J
Side Door Completion or Sleeve Valve
Baker Locator Tubing Seal Assembly Product No. 442-E2
Baker Retainer Production Packer Product No. 415
Baker Production Tube Product No. 457

CATALOG SUPPLEMENT NO. 357 describes Baker Snap-Set Dual Packers in complete detail.

BAKER OIL TOOLS, INC. HOUSTON LOS ANGELES NEW YORK

DEEP drilling finds DEEP production

Out of 119 producers, 82 have pay sands below 15,000 ft . . . One in four of the super-deep wildcats discovered oil and/or gas in 1959 . . . greater efficiency has cut time and costs of depth operations . . .

Ernestine Adams

DEEP WELLS MADE an amazing record in 1959. Briefly, here are 10 chief facts:

1. 228 holes were drilled 15,000 ft or below — 19 percent more than in 1958 (we predicted 230 a year ago).
2. 22 new fields were discovered, nine of them below 15,000 ft, with a total of 94 wildcats. This is almost one discovery in four holes drilled.
3. 48 extensions to fields were made by field wildcats. These are new pay sands or area extensions.
4. 49 producers were added by field wells drilled; 37 development wells were dry.
5. Counting all field wells, including field wildcats (134 wells), 72 percent were completed as producers.
6. Of the 119 producers in 1959, 82 have pay sands below 15,000 ft. This means 69 percent are deep producers compared to 52 percent in all previous years.
7. 13 fields were added to make a total of 48 fields with production below 15,000 ft.
8. Deepest well in the world went to 25,340 ft. Total depth was reached in time for last year's survey but well was completed as a dry hole in 1959.
9. Nearly $150 million was spent in 1959 on wells below 15,000 ft.
10. At $40.48, drilling costs per foot are the lowest since 1955.

Deep Discoveries

In the list of new fields found by deep holes 9 discovery wells can produce below 15,000 ft and one has not been perforated.

Union Oil of California found the deepest field of the year at 17,242-60 ft in Lafourche Parish in the East Timbalier Bay area. Initial production was 255 b/d oil and 5000 Mcf/d gas.

Standard Oil of Texas re-entered a well drilled to 12,508 ft (in 1957) in Grayson County, Texas and took it to 16,550 ft for production at that depth. It has not been tested.

Pure Oil found a gas-condensate field in Galveston County, Texas at 16,132-264 ft.

Tidewater discovered gas-condensate at 16,112-30 ft in the Lacassine Refuge, Cameron Parish, Louisiana.

Skelly made a dual gas discovery in Vermilion Parish with production from 14,990-15,000 and 15,514-16 ft.

John W. Mecom-Freeport Oil went to 20,752 ft in Plaquemines, Louisiana and discovered oil at 15,300-14 ft.

Gulf Oil discovered a new field and a new sand with one deep hole at Redfish Point, Vermilion Parish. The lower pay is 15,172-89 ft.

Quintana Petroleum found a 15,050-60-ft gas pay in Garden City, St. Mary Parish.

Sunray Mid-Continent drilled deeper in a 1958 wildcat and discovered a gas-condensate field at 15,040 ft in St. Mary Parish.

Besides these nine wells that discovered deep fields, 11 other deep holes tapped new reservoirs, some very good ones. (See Table 6.)

THANKS TO DEEP WELL OPERATORS

this survey is possible. We have had virtually total cooperation in gathering the information collected here. Our sincere appreciation goes to these oil companies that provide essential data, particularly cost figures.

Deep Fields

Last year brought number of deep fields up to 48. (Table 3.) Sun Oil, after several deep tests found production in a new "X-1" sand at 15,044-48 ft in Belle Isle field, Louisiana. Shortly after, Sun completed another deep well in a new sand at 17,573-80 ft, making

Miss Adams is Management Editor

TABLE 1. NUMBER OF WELLS COMPLETED 15,000 FT AND BELOW BY YEARS OF COMPLETION

Year	No. wells by date of completion	Exploratory*	Producers	Average drilling time	Record drilling time	Average bits per well	Low bit record	Mud costs, average	Well costs, average	Average costs per ft	Total footage drilled	Ft/well average	Deepest well	Deepest producer
1938	1	1	1	—	284		195				15,004	—	15,004	13,175
1944	1	1	0	—	—	—	—	—	—	—	15,279	—	15,279	13,175
1945	3	3	0	490	—	222	—	—	—	—	63,480	15,870	16,655	13,175
1946	1	1	1	—	349	—	184	—	—	—	15,452	—	16,655	13,175
1947	8	8	1	267	121	181	73	$ 24,000	$570,000	$35.87	127,128	15,891	17,823	13,904
1948	7	6	2	328	113	303	99	28,000	551,000	34.34	112,329	16,047	17,823	14,255
1949	11	8	5	222	95	199	120	64,000	534,000	32.52	180,631	16,421	20,521	15,530
1950	5	2	3	235	150	181	106	63,000	577,000	36.72	78,565	15,713	20,521	15,530
1951	12	5	6	178	96	116	69	54,000	527,000	33.56	189,864	15,822	20,521	15,530
1952	25	17	9	212	83	138	44	66,000	549,000	34.77	396,850	15,874	20,521	16,012
1953	26	14	20	213	70	159	48	75,000	729,000	44.79	419,053	16,117	21,482	17,895
1954	58	30	31	182	71	117	40	92,000	651,000	40.87	923,879	15,929	21,482	17,895
1955	101	64	43	147	37	87	44	116,000	649,000	40.09	1,635,101	16,031	22,559	17,895
1956	154	77	78	150	36	89	31	122,000	683,000	42.18	2,494,062	15,988	22,559	20,745
1957	189	116	89	157	48	89	30	121,000	743,000	46.25	3,052,097	16,064	22,559	20,745
1958	191	134	100	130	34	79	24	107,000	692,000	43.18	3,075,648	16,019	25,340	20,745
1959	228	142	119	114	30	71	25	83,000	650,000	40.48	3,660,857	16,056	25,340	20,745
Overall	1,021	629	508	—	30	—	24	$102,000	675,000	41.90	16,455,279	16,116	25,340	20,754

*This includes field wildcats.

Belle Isle the fourth deepest field in the world. Sun discovered the field in 1955 with a 15,500-ft well. First production was at 12,079-85 ft. In 1959 two deep wells extended the field below 13,000 ft and below 14,000 ft.

In 1957 Wm. T. Burton Industries discovered Lake Palourde field in St. Mary Parish, Louisiana with a 17,768-ft well. In 1958 another well tapped the 14,744-65 ft sand. This year the company extended the field to production at 15,675-9 ft.

Deeper production was added to Leleux field in Vermilion Parish, Louisiana by Union Oil and Gas of Louisiana. Union discovered this gas-condensate field in 1958 with production at 15,612 ft and last year found production at 16,928 ft.

Shell Oil Company discovered a gas-condensate field at 12,782 ft in Block 139 Ship Shoal in 1957. This year an oil sand was found at 15,032 ft with 420 bbl a day production.

Two deep new gas pays were added to Lake Washington field by John W. Mecom. One was completed as a dual producer—the sands about a thousand feet apart.

Union Oil of California and Pan American discovered a deep gas pay in Timbalier Bay field. Deepest production had been 15,730 ft. New production depth is 17,242-60 ft.

The first oil sand in Block 139 was discovered below 15,000 ft offshore Terrebonne, Louisiana. Shell found a gas field there in 1957 below 12,000 ft and this year added oil production at 15,012-32 ft.

Lapeyrouse field in Terrebonne Parish, Louisiana, got a real spurt in deep producers. Five were added to the three already producing from below 15,000. Placid Oil drilled four extensions to the field and Arkansas Fuel Oil Corporation drilled one extension. All opened large gas-condensate deposits.

Texaco doubled the number of deep producers in Lake Barre field, Louisiana, and now has 18 wells producing from below 15,000 to 17,288 ft.

Weeks Island is still far ahead with number of deep producers. The three Shell added this year makes 33 wells that have produced from below 15,000 ft, a world record.

Superior Oil added 6 deep producers to Four Isle Dome. Three discovered new sands at 15,846-61 ft, 16,788-806 ft and 16,898-908 ft, respectively.

Texaco and Sun Oil each added a deep producer to Lake Pelto.

Deep Drilling Costs

A total of more than $148 million was spent in 1959 on the 228 deep wells. Previous high was $140 million on 189 wells in 1957.

About one in five wells below 15,000 ft still cost approximately $1 million or more. One ran above $3 million in 1959 and it was not the new depth record well.

Costs per well range from these vast sums all the way down to less than $200,000, but there are few of these.

Average cost per well dropped $42,000 to $650,000 each in 1959. This is $40.48 a foot — a 6 percent decrease and is exceptional in the face of rising costs of labor and materials. Drilling time has been cut 16 days on the average, which is an important saving and few bits per well were used. In other words, experience is paying off. (Table 1.)

John W. Mecom, a successful deep

TABLE 2. LOCATION AND AVERAGES OF WELLS DRILLED 15,000 FT AND BELOW

State	Number wells 1959	Total 15,000 ft holes	Completed as producers	Drilling time average days	Low drilling time record	Average bits per well	Low bit record	Deepest hole	Mud costs, average	Well cost average
Alabama	0	3	0	225		186		15,729	$ 55,000	$511,000
California	5	50	12	173	44	153	56	21,482	80,000	596,000
Colorado	0	3	2	226	90	179	94	17,033	74,000	603,000
Florida	1	2	0				144	15,474		
Louisiana	184	759	413	101	30	69	24	22,570	101,000	651,000
Mississippi	7	21	8	195	83	129	76	20,450	58,000	551,000
New Mexico	1	16	10	327	222	238	172	17,555	124,000	918,000
North Dakota	1	1	0					15,135		
Oklahoma	3	34	15	320	165	218	128	24,004	114,000	915,000
Texas	24	122	44	219	50	142	25	25,340	118,000	746,000
Wyoming	2	10	4	385	318	252	199	20,521	74,000	904,000
TOTALS	228	1021	508		30		24	25,340		

TABLE 3. FIELDS WITH PRODUCTION 15,000 FT AND BELOW

First deep production	Date found	Field	County or Parish	No. wells drilled below 15,000 ft.	No. wells that produced below 15,000 ft.	Deepest production ft.
CALIFORNIA						
Richfield	1953	N. Coles Levee	Kern	1	1	17,895
Standard of Calif.	1949	Wasco	Kern	3	1	15,530
LOUISIANA						
Tidewater	1956	Rayne Lane Well	Acadia	10	1	15,270
Union Producing	1956	Deep Lake	Cameron	7	1	15,410
Tidewater	1959	Lacassine	Cameron	1	1	16,130
Humble O&R	1956	Avery Is.	Iberia	4	3	15,496
Shell	1952	Weeks Is.	Iberia & St. Mary	32	33	17,745
Texaco	1954	Queen Bess Is.	Jefferson	6	4	16,149
Union O&G of La.	1956	Lake Arthur	Jefferson Davis	7	3	15,784
Caroline Hunt Sands	1958	So. Thornwell	Jefferson Davis	8	2	15,398
Texaco	1956	Bay de Chene	Lafourche & Jefferson	5	2	15,500
Gulf Oil	1956	Timbalier Bay	Lafourche	8	2	17,260
Union of Calif.	1959	E. Timbalier	Lafourche	1	1	17,260
Grande Corp.	1957	St. John	Lafourche	3	2	15,210
John Mecom	1959	Home Place	Plaquemines	1	1	15,314
John Mecom	1954	Lake Washington	Plaquemines	27	9	20,745
Tidewater	1956	Venice	Plaquemines	6	2	16,060
Pan American	1958	Bastian Bay	Plaquemines	13	1	15,335
Sid Richardson Car.	1956	Cade	St. Martin	2	1	15,085
Sun Oil	1958	Belle Isle	St. Mary	7	1	17,580
Texaco	1954	Cote Blanche Is.	St. Mary	20	7	17,000
Sunray Mid-Con.	1959	East Lake Sands	St. Mary	1	1	15,040
Humble O&R	1958	Eugene Is. SS	St. Mary	12	1	15,885
Wm. T. Burton	1959	Lake Palourde	St. Mary	3	1	15,679
Quintana	1959	Garden City	St. Mary	1	1	15,060
Superior Oil	1956	Bayou Rambio	Terrebonne	6	2	15,034
Texaco	1956	Caillou Is.	Terrebonne	33	6	16,116
Pan American-Hunt	1957	Block 39 SS	Terrebonne	1	1	16,842
Shell	1959	Block 139 SS	Terrebonne	1	1	15,032
Texaco	1954	Dog Lake	Terrebonne	6	2	15,879
Superior Oil	1956	Four Isle Dome	Terrebonne	7	10	16,908
Texaco	1956	Lake Barre	Terrebonne	13	18	17,288
Sun Oil	1956	Lake Pelto	Terrebonne	11	6	16,084
Placid	1956	Lapeyrouse	Terrebonne	8	8	16,100
Sid Richardson	1957	Abbeville	Vermilion	2	1	15,012
Union O&G of La.	1958	Leleux	Vermilion	2	1	16,928
Gulf	1959	Redfish Point	Vermilion	1	1	15,189
Sid Richardson Car.	1958	Riceville	Vermilion	3	2	15,880
Skelly	1959	(not named)	Vermilion	1	1	15,516
MISSISSIPPI						
Gulf	1958	Soso	Jasper	2	1	15,256
NEW MEXICO						
Continental	1955	San Simon	Lea	1	1	15,025
OKLAHOMA						
British American	1956	Carter-Knox	Grady & Stephens	14	10	17,382
Gulf Oil		New Hope	McClain	1	1	18,944
TEXAS						
Pure Oil	1959	S. Hitchcock	Galveston	1	1	16,264
Standard Texas	1959	(not named)	Grayson	1	1	16,550
Phillips	1953	Puckett-Ellenbgr.	Pecos	5	5	15,324
WYOMING						
Pure	1952	W. Poison Spider	Natrona	2	2	16,102
Pure	1957	Badwater	Natrona	2	1	16,477
TOTAL		**48 Fields**	**7 States**	**313**	**154**	**20,745**

operator, says deep drilling has proved oil and gas are down there if it will pay to go after it. Continued improvements in methods and equipment, with resultant lowering of costs may bring a rush of deep drilling.

Drilling Mud

The drilling mud programs in Table 6 show considerable variety. Costs have as wide a range — from under $15,000 to about a quarter of a million, which two wells required. Even this is not a record.

But the important news is the biggest drop in average mud cost per well ever recorded. In 1958 the mud cost decreased $14,000 per well to $107,000. Last year another $24,000 per well was dropped from average costs to bring the sum to $83,207. This shows real advancement in mud quality and techniques for using drilling mud more effectively.

Some offshore wells and West Texas run into high mud costs. Lowest figures show up in Shell's Weeks Island field. Long experience here pays off. There were 34 wells drilled with mud costing less than $30,000 each but also there were 70 wells with mud costs of more than $100,000 each.

Drilling Bits

Although low record for number of drilling bits used on one well in 1959 was one more than the 1958 record, average bits used went to 71 bits per well. This is 8 bits less for each hole on the average.

Bits used ranged from 25 on Phillips field well in Alta Loma, Galveston County, Texas, to the 318 bits which took the same company's University No. 1 to 25,340 ft.

In 1949 the average deep well took 199 bits so the improvement in drilling bits and the use of them has cut number required to almost one-third in 10 years.

Drilling Time

Despite proportionately more wildcats and semi-wildcats in 1959, drilling time was cut 12 percent; that is 16 days less, on the average was needed to complete a well at the deeper levels.

We did not include the World's deepest well as it is highly individual. So the 755 days drilling required for No. 1 University "EE" would have brought up the average some. Grande Corporation's 21,025 ft well in Caddo County, Oklahoma, which had 429 drilling days, and others that took as much as a year to drill were among the wells, however.

It is the increase of fast-drilled wells that cuts average time. Shell holds the new low record — only 30 days to

TABLE 4. PRODUCING DEPTHS OF DEEP WELLS

Producing depth, ft.	No. producers to 1959	1959	Total
2- 3000	2		2
4- 5000	3		3
5- 6000	2		2
6- 7000	4	1	5
7- 8000	6		6
8- 9000	11		11
9-10,000	10	3	13
10-11,000	18	2	20
11-12,000	23	3	26
12-13,000	46	8	54
13-14,000	61	20	81
14-15,000	82	31	113
15-16,000	86	35	121
16-17,000	24	13	37
17-18,000	9	3	12
18-19,000	1		1
19-20,000	1		1
20,000+	1		1
TOTAL PRODUCERS.	389	119	508

TABLE 6. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW

1. TD, ft 2. Prod. depth(s)	1. Company 2. Well	Drilled by	1. Field or area 2. County/Parish	1. Completed 2. Spudded	Mud program	Perf. in prod. zones	1. Initial prod., gravity 2. Coke, tubing pressure	Remarks
			CALIFORNIA					
15,414 D&A	Atlantic-Gen. Petr. et al KCL 71	Rocky Mt.	Paloma Kern	4-16-59 1-19-59	Fresh water, Kylo mud w/weight mat.			WC. Drilled in 88 days.
15,978 D&A	Stan. Oil (Cal.) Carlin #1	K. L. Kellogg & Sons	Lynwood area Los Angles	2-20-59 10-27-58				WC.
16,421 D&A	Richfield Oil KCL-#22-15	Rocky Mt.	Wheeler Ridge area Kern	2-26-59 9-27-58	Clay base emul w/crude oil 80#-105#			WC.
16,457 D&A	Union Oil Calif. Irwin Berylwood #5	Drilling & Exploration	Barsdale Ventura	7-25-59 4-25-59				WC. Drilled in 65 days.
			FLORIDA					
15,474 D&A	Gulf Oil #1 St. of Fla. 826-Y	Kerr-McGee	WC. Monroe	8-21-59 2-17-59	To 7909' aerated sea water; below, fresh water.			WC.
			LOUISIANA					
15,000 13,280	Sunray Mid-Cont. #7 Mary E. McConnell	Falcon Seaboard Drlg.	South Duson Lafayette	8- 7-59 3-30-59	Lime base mud w/10% oil emul.	13,250-280	3 b/d cond. 1800 Mcf $^{16}/_{64}$" FTP 6000	FW. Extended field in Bolvina Mexicana "1" sd. 50'. 99 days to drill.
15,000 14,096	Texaco #14 Mary S. Nelson	Wheless	Point Au Fer Terrebonne	8-10-59 1-22-59		14,080-096		WC. Gas (no gge-SI) SE exten.
15,001 13,910	Sun Oil #1 St. Agency "A" Belle Isle Corp.	Co. tools	Belle Isle St. Mary	11-20-59 8-21-59	Kembreak oil emul.	13,904-910		FW. SI gas. Extended field in "P" sand 33'. 65 days to drill. 55 bits.
15,002 Dry	David S. Thayer, #2 St. Lse 3093	Winn Hawkins	WC. Vermilion	7-28-59 4-24-59				WC.
15,006 13,940	Calif. Co. #7 La Terre Co., Inc.		Bay Penchant Terrebonne	1-28-59 11-22-58		13,910-940	No gge. $^{1}/_{4}$" TP 6150	Semi-WC. Gas Well.
15,010 14,497	Sinclair O&G #1 Salvadore Segretto		WC. Lafourche	7- 4-59 11-26-58		14,486-497	177 b/d 40.9° 157 Mcf $^{5}/_{64}$" TP 6800	WC. New oil disc.
15,025 11,214	Geo. R. Brown #1 Carrie Randel	H.E.T. Drlg. Co.	Abbeville Vermilion	7-29-59 5- 8-59	Gyp mud 17.2# @ TD	11,210-214	60 b/d 47.4° 4055 Mcf $^{14}/_{64}$" TP 3250	FW. Extended field in Miocene sd. 18'. 78 days to drill. 42 bits.
15,068 14,864	Superior Oil #1 Humble Fee	Rowan Drlg.	Lac Blanc Vermilion	8-24-59 5- 3-59	18.1/72/1.2 at TD	14,838-864	88 b/d cond. 45.0° 8394 Mcf $^{14}/_{64}$" TP 9575 (DWG)	WC. Extended field in 69 sd. 65'. 94 days to drill. 68 bits. CI—Gas cond. well. Perf. squeezed off to comp. at later date.
15,070 10,434	Altanta Ref. So. Coast Corp. #1	Fred Wilson Drlg.	Jeanerette St. Mary	2- 4-59 9-27-58	Gyp OE 10-16.5#	10,434	215 b/d 37° 230 Mcf $^{5}/_{64}$" TP 2625	WC. New field. 81 days to drill. 60 bits. Adeline 8'.
15,081 Dry	Pan Am. Petr. #8 Buras Lev. Dist.		Bastian Bay Plaquemines	4-28-59 3-15-59				FW.
15,085 14,913	Texaco #3 Lake Barre Un. 28	Wheless	Lake Barre Terrebonne	8- 5-59 2- 9-58		14,895-913	348 b/d 29.5° 345 Mcf S-31 TP 2850	FW.
15,085 14,429	Texaco #6 Lk. Barre Un. 38		Lake Barre Terrebonne	5- 8-59 2-16-59		14,412-429	272 b/d 30.2° 326 Mcf S-33 TP 2250	FW.
15,086 Dry	Placid Oil et al #6 St-LL&E Un. 14	Penrod Drlg.	Lake Washington Plaquemines	8- 6-59 6-28-59	9.5; pH 7.5 to Mud 12; pH 13.0			FW. 38 days to drill. 32 bits.
15,086 J&A	El Paso Nat. Gas #1 A St. Martin Ld. Co.		WC. Terrebonne	7- 6-59 4- 4-59				WC.
15,095 Dry	Sinclair O&G #1 E. A. McIlhenny	Thirteen Drlg.	WC. Vermilion	6- 5-59 1- 4-59				WC.
15,100 Dry	Sun Oil #46 Belle Isle	Company tools	Bell Isle St. Mary	1-23-59 11- 3-58	Kembreak oil emul.			FW. 65 days to drill. 47 bits.
15,102 15,060	Quintana Petr. #1 Williams Inc. Un. 2	Rowan Drlg.	Garden City St. Mary	9-26-59 3-10-59	Lime base 17.5 at TD	15,050-60	70 b/d 5000 Mcf Adj. TP 10,750.	WC.
15,103 14,386	Texaco #10 Lake Pelto Un. 14		Lake Pelto Terrebonne	11- 3-59 7- 8-59		14,372-386	291 b/d 30° 314 Mcf S-26 TP 5100	FW.
15,106 13,884 13,850	Union O&G Corp. of La. #4 Marie Van Geffen	Gordon Drlg.	Lake Arthur Jefferson Davis	5- 6-59 12- 3-58	High pH Lime base oil emul.	13,864-884 13,798-850	70 b/d 40.6° 4115 Mcf $^{17}/_{64}$" TP 8800 on $1^{1}/_{4}$"	FW. Camerina sd. 100'. 63 bits.
15,120 13,160	Texaco #17 Lake Pelto Un. 5		Lake Pelto Terrebonne	7-15-59 3-26-59		13,132-60	227 b/d 30.2° S-31 TP 2250	FW.
15,120 15,032	Shell Oil OCS-0588 #1	Dixilyn Drlg.	Ship Shoal Terrebonne	1- 4-60 11-17-59	Comb. fresh water CS Queb. & salt water CS Q-Broxin	15,010-32	420 b/d 37.6° 620 Mcf $^{18}/_{64}$" TP 3000	WC. First oil sd. Miocene. 38 days to drill. 40 bits.
15,141 14,904	Sun Oil #77 Dibert, Stark & Brown	Company Unit	Chacahoula Lafourche	2-24-59 9- 7-58	Kembreak lime oil emul.	14,898-904	336 b/d 38.5° 126 Mcf $^{1}/_{8}$" TP 2250	Pool WC. New sd. Levert "G" 6' 94 bits.
15,146 Dry	Placid Oil #2 OCS 0477	Penrod	WC. St. Mary	4-26-59 3- 9-59				WC.
15,155 TA	F. A. Callery #1 E. P. Brady et al	Brewster-Bartle	Bayou de Fleur Jefferson	2- 2-59 7- 6-58		12,704-18	104 b/d 43.8° $^{18}/_{64}$" TP 2600	FW. Six sands tested but nothing commercial. TA.
15,160 D&A	Humble O&R #1 OCS-0596	Kerr McGee	South Timbalier Blk 35 Terrebonne	6-25-59 5- 7-59	Gyp-Q-Broxin oil emul. Max. wt. 13.6#/gal.			WC. 45 days to drill.

TABLE 6. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	1. Company 2. Well	Drilled by	1. Field or area 2. County/Parish	1. Completed 2. Spudded	Mud program	Perf. in prod. zones	1. Initial prod., gravity 2. Coke, tubing pressure	Remarks
			LOUISIANA — (continued)					
15,170 13,022 13,332	Hassie Hunt Trs. et al #1-A Verdin-Parro et al Un. 1	Penrod	Rousseau Lafourche	7-13-59 4- 6-59	Gyp-Q-Broxin oil emul. Max. wt. 18.2#/gal.	13,004-22 13,316-32	164 b/d 46.6° 2100 Mcf 15/64" TP 9645 47 b/d 54.10° 4250 Mcf 15/64" TP 9415	Dual Comp. Extended field. 64 days to drill. 51 bits.
15,171 14,090 14,520	John W. Mecom #6 St. Lse 2028	Co. rig	Lake Washington Plaquemines	4-17-59 2- 9-59	Gyp-Q-Broxin	14,080-90 14,500-20	300 b/d 34° 596 Mcf 5/64" TP 4800	FW. Dual oil & gas. extended field. 81 days to drill. 52 bits.
15,183 D&A	Humble O&R #B-9 La. Delta Farms	Co. rig	Little Temple Lafourche	10-24-59 8- 4-59	Gyp-Q-Broxin oil emul Max. wt. 18.5#/gal.			FWC.
15,190 13,525 14,624	Placid Oil #8 St. Lse 2376-LL&E Un. 13	Penrod	Lake Washington Plaquemines	1-12-59 11-23-58	Mud 9.7; pH 7 to mud 11.8; pH 10	13,500-25 14,614-24	305 b/d 27.4° 5/64" 191 b/d 50.9° 3000 Mcf 13/64". SITP 4074.	Dual well. Extended field in Miocene sd. 41 days to drill. 41 bits.
15,200 13,644	Texaco et al #1 Adolfe Lyons, Un. 4	Loffland	Grosse Isle Vermilion	7- 3-59 2-23-59		13,616-27-	13 b/d 47.5° 900 Mcf 3/64" TP 8325	FW. New gas pay.
15,226 14,923	Texaco LLS&E #2 St. Lse 3005		Leeville Lafourche	11- 9-59 7-12-59		14,914-23	192 b/d 29.2° 171 Mcf 3/64" TP 3900	FW. Extension.
15,235 TA	Texaco #B-6 Continental Ld. & Fur Co.		Sweet Bay Lake Terrebonne	5-12-59 2- 5-59				WC.
15,241 15,040	Sunray Mid-Con. #1 St. Lse 3132	Crown Rigs, Inc.	East Lake Sands St. Mary	5-13-59 12-24-58	Low lime-driscose	15,040	268 b/d 59.6° 640 Mcf 15/64" FTP 2500	WC. New field in Cibicides 38. Well re-drilled from 11,000'
15,250 14,140	Texaco #1 A. T. Leger et al Un. 1	Nicklos Drlg. Co.	S. Bosco Lafayette	4-28-59 11-22-58		14,130-40	169 b/d 43.8° 474 Mcf 7/64" TP 3100	FW. S. exten.
15,253 13,499 14,640	Placid Oil #1 Clarence W. Baughman	Penrod	Patterson St. Mary	8-29-59 5-31-59	Mud 9.5; pH 10 to Mud 12.3; pH 9.5	13,487-99 14,620-40	314 b/d 34.6° 69 b/d 41.1° 3015 Mcf 3/64" TP 5200;	WC. New field. Dual comp. Miocene 12', 50'. 69 days to drill. 63 bits.
15,257 14,528 14,004	Texaco #46 St. Lse 340-CBI		Cote Blanche Isle St. Mary	5-28-59 2- 6-59		14,513-28 13,997- 14,004	211 b/d 29.1° 402 b/d 27.5° 357 Mcf 7/64", 15/64" TP 2200;1850	FW.
15,262 Dry	Pan Am. Petr. #7 Buras Levee Dist.	Sharp-Gulf Drlg.	Bastian Bay Plaquemines	5-24-59 4-16-59				FW.
15,276 D&A	Superior Oil #A-2 Southdown Inc.	Co. rig	Sunrise Terrebonne	12- 1-59 9- 1-59	18.3# at TD			FW. 87 days to drill. 44 bits.
15,281 Dry	Gulf Oil #2 St. Lse 3306	Brewster-Bartle	Redfish Point Vermilion	11-15-59 9- 5-59	Wt. 9.5# to 10.0# from surf. to 11,100'; 10.0# to 13.8# 11,100' to TD			FW. 68 days to drill. 45 bits.
15,300 13,272	Gulf Oil La. St. PP #38	Producers Drlg.	West Bay Plaquemines	4- 9-59 1-30-59	Native bay water mud to 8,500'; gyp & quebroxin 8,500' to TD w/wt. 10.9# to 17.9#.	13,272	440 b/d 32.2° 485 Mcf 5/64" TP 6900	WC. Disc. new No. 16 sand 40'. 57 days to drill. 30 bits.
15,300 15,190	Shell Oil #A-2 J. A. Smith	Co. tools	Weeks Island Iberia	3- 3-59 1-21-59	11.3#/gal. low pH red	15,190	216 b/d 29.5° 172 Mcf 13/64" TP 1045	DW. Miocene sd. 46'. 30 days to drill. 37 bits.
15,302 12,590	Union O&G of La. #5 Marie H. Van Geffen	Gordon Drlg.	Lake Charles Jefferson Davis	9-28-59 5-22-59	Gyp-Q-Broxin oil emul.	12,560-90	96 b/d 38.8° 5275 Mcf Adj. choke, TP 5500	Camerina sd. 200'. 75 bits.
15,309 Dry	Texaco Trunkline-Cyprus. #1 C.S.Stearn-Syrup. Un. 2	Webster Drlg.	Grosse Isle Vermilion	8-12-59 3-10-59				FW.
15,322 15,210	Ark. Fuel Oil #1 Invincible Fee	Penrod	Lapeyrouse Terrebonne	9-25-59 8-1 -59		15,180-210	53° 4,048 Mcf 17/64" TP 5035	FW.
15,322 15,210	Placid Oil et al Ark. Fuel Oil Invincible Fee Un. #1-1	Penrod	Lapeyrouse Terrebonne	9-25-59 8- 1-59	Mud 10.0; pH 8 to Mud 14.7; pH 11.5	15,180-210	192 b/d 48.8° 6859 Mcf 16/64" TP 4480#	FW. Ext. fld. Miocene sd. 68' 50 days to drill.
15,340 13,206 13,518	Sun Oil #6 St. Lse 2620	Brewster-Bartle	Lake Pelto Terrebonne	1-10-59 10- 7-58	Kembreak lime oil emul.	13,200-6 13,500-18	203 b/d 34.2° 180 Mcf 1/4" TP 1900; 293 b/d 35.7° 310 Mcf 1/8" TP 2300	FW. Dual comp. "H" sand 15'; "K" sand 25'. 76 days to drill. 53 bits.
15,350 15,277	Texaco #14 Lk. Pelto Un. 5	Co. tools	Lake Pelto Terrebonne	1- 8-59 9-27-59		15,265-77	341 b/d 37.4° 394 Mcf S-26 TP 5250	FW.
15,353 D&A	Superior Oil Grand Lake St. Lse 3016 #1	Co. rig	S. Grand Lake Prospect Cameron	12-12-59 7-10-59	18.3# at TD			WC. 77 bits.
15,368 14,818	Texaco #1 Edier Bares	Loffland	Parcperdue Vermilion	12-28-59 8-13-59		14,810-18	34 b/d 46.4° 2,679 Mcf TP 10,250	WC. New gas pay.
15,376 13,840 13,978	Gulf Oil #60 La. St. Lse 1772	Falcon Seaboard	Timbalier Bay Lafourche	12-22-59 9- 7-59	Wt. 9.5# to 10.5# from surf. to 10,500'; 10.5# to 16.0# from 10,500' to TD	13,840 13,978	140 b/d 55.5° 1285 Mcf 8/64" TP 4100; 278 b/d 25.2° 442 Mcf 18/64" TP 1600	Dual comp. Extended fld. in two Miocene sands 45'; 78'. 83 days to drill. 56 bits.
15,376 11,317	George R. Brown #1 L. M. Wise	H. E. T. Drlg.	Abbeville Vermilion	3-15-59 12-11-58	Gyp Mud 17.4# @ TD	11,315-17	520 b/d 42° 311 Mcf 11/64" TP 1050	WC. New field. Miocene sand 18'. 83 days to drill. 50 bits.
15,380 12,750	Texaco #6 S. La. Canal & Navi. Co.	Offshore Drlg. Co.	Leeville Lefourche	8-15-59 4-18-59		12,736-50	160 b/d 37.2° 117 Mcf S-27 TP 2475	WC.
15,392 Dry	Calif. Co. #1 Sallie F. Melancon et al		WC. Terrebonne	11-11-59 4-29-59				WC.
15,400 15,327	Texaco #2 Lk. Barre Un. 36		Lake Barre Terrebonne	10- 4-59 8- 2-59		15,312-27	192 b/d 48.9° 1224 Mcf S-32 TP 4900	FWC. Extension.
15,400 15,048	Sun Oil #48 Belle Isle Corp.	Co. tools	Belle Isle St. Mary	5-29-59 2-19-59	Kembreak oil emul.	15,044-48	222 b/d 30.8° 440 Mcf 6/64" TP 8600	FW. "X-1" sd. 18'. 83 days to drill. 48 bits.

TABLE 6. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	1. Company 2. Well	Drilled by	1. Field or area 2. County/Parish	1. Completed 2. Spudded	Mud program	Perf. in prod. zones	1. Initial prod., gravity 2. Coke, tubing pressure	Remarks
			LOUISIANA — (continued)					
15,400 Dry	Tidewater #B-1 E. A. McIlhenny	Falcon-Seaboard	Buck Point area Vermilion	8-23-59 2-23-59	Max. wt. 18.3#/gal. Gyp. mud			WC. Drill pipe stuck while drilling at 14,687'; Backed off and sd. trkd hole at 12,155'; 88 bits.
15,410 Dry	Lone Star Prod. #4 Gulf States Ld. & Ind.	J. D. Ward Drlg.	Raceland Lafourche	4-29-59 1-30-59	17.5#/gal.			FW. 89 days to drill. 42 bits.
15,430 15,189 14,654	Gulf Oil # I St. Lse 3306	Brewster-Bartle	Redfish Point Vermilion	3-11-59 7-26-58	Wt. 9.5# to 10.0# from surf. to 9900'; 10.0# to 15.1# from 9900' to TD.	15,172-89 14,640-54	328 b/d 48.9° 4 Mcf 15/64" TP 3310; 336 b/d 55.8° 3 Mcf 15/64" TP 3400	WC. Dual comp. Disc. new field & new sd. 84 bits.
15,430 15,390	Placid Oil et al Invincible Fee Un. #2-1	Penrod	Lapeyrouse Terrebonne	12-24-59 10-29-59	Mud. 9.8° pH 11 to Mud 14.4; pH 11.8	15,365-90	5050 Mcf 15/64" TP 4525	FW. Extended field. in Miocene sd. 85'. 52 days to drill. 56 bits.
15,433 14,387	The Grande Corp. #2 Caldwell Sugars	Co. rig	St. John Lafourche	9- 4-59 6-24-59	Lime base oil emul.	14,364-87	261 b/d 4000 Mcf 15/64" TP 5775	FW. Opere. Caldwell sd. 23'. 72 days to drill. 43 bits.
15,441 15,390	Ark. Fuel Oil #1 Invincible Fee Un. 2	Penrod	Lapeyrouse Terrebonne	12-24-59 10-29-59	Calcium cloride	15,365-90	141.40 b/d 48.8° 5050 Mcf 15/64" TP 4525	FW. Extended field in Miocene sd. 51 days to drill. 56 bits.
15,467 Dry	Richardson & Bass #1 Praford J. Woods	Co. rig	Riceville Vermilion	4-11-59 12-12-58				FW. P&A. 72 bits.
15,475 Dry	Gulf Oil St. Lse 2869 #3	Gulf Marine Drlg.	West Delta Blk 27 Gulf of Mexico	12-15-59 10-14-59	Nat. sea water mud to 8000'; Gyp. & Quebroxin from 8000' to TD (wt. at TD 14.5#)			FW. 54 days to drill. 44 bits.
15,481 14,938	Texaco #8 Lake Barre Un. 38	Norton Drlg. Co.	Lake Barre Terrebonne	11-13-59 8- 9-59		14,935-38	192 b/d 30.3° 181 Mcf S-30 TP 2100	FW.
15,500 12,762	Richardson & Bass Carmelite A. Stutes	Dillard & Waltermire	South Scott Lafayette	2-21-59 9-17-58		12,756-62	69 b/d 47.0° 2350 Mcf 7/64" TP 8850	WC. New field. Marginulina texana sd. 14'. 49 bits.
15,500 Dry	Gulf Oil #40 La. St. "PP" 192	Cron and Gracey	West Bay Plaquemines	2-27-59 12- 2-58	Native bay water mud to 8,700'; Gyp. & Quebroxin from 8,700' to TD w/wt. 10.7# to 17.1#			WC. 79 days to drill. 43 bits.
15,500 Dry	J. C. Trahan Drlg. #1 LL&E Co.		WC. Lafourche	5- 3-59 2-11-59				WC.
15,500	Humble O&R #2 St. Lse 3055	Rowan	Lac Blanc Vermilion	11-15-59 8-18-59	Gyp-Q-Broxin w/oil & Graphite. Max. mud wt. 19.2#/gal.			FW. Extended field in Discorbis sd. Potential well standing. Not perforated or tested. 75 days drilling.
15,500 14,056	Texaco #24-B St. Lse 329-E CBB		Bayou Sale St. Mary	5-28-59 12-27-58		14,038-56		Oil (SI, no gge.)
15,501 TA	Gulf Oil #2 St. Lse 3304	Brewster-Bartle	Vermilion Bay area Vermilion	8-15-59 5-16-59	Wt. 9.5# to 10.0# from surf. to 10,225'; 10.0# to 14.0# to TD			FW. 90 days to drill. 81 bits.
15,518 Dry	Atlantic #1 Fernand Landry	Clegg & Hunt	Delcambre area Iberia	4-27-59 1-14-59	Gyp OE 12- 18.1#			WC. 67 bits.
15,520 14,498	Texaco #1 Joseph W. Boudreaux Un. 6	Loffland Bros.	Grcss Isle Vermilion	11- 4-59 7-17-59		14,467-98	432 b/d 50.5° 3,175 Mcf 9/64" TP 9500	FW.
15,531 9,690	Hunt Oil et al #14 St. Lse 1392	Penrod	Duck Lake St. Martin	12-13-59 9-21-59	Gyp-Q-Broxin 16.8#	9,687-90	250 b/d 51.6° 1500/1 Mcf 9/64" TP S. I. 1375	FW. Extended field in Opere 5 sd. 77 days to drill. 63 bits.
15,549 14,050	Union Oil of Cal. LL&E #2 St. Lse 3088	Gracey-Hellums	Timbalier Bay Lafourche	2-28-59 11-14-58	Native sea water mud to 10,700' oil emul. T-8 to TD	14,042-50	205 b/d 36.7° 270 Mcf 7/64" TP 2100	FW. Drld. to 14,819'. Set whipstk & sdtrckd hole from 9,955-15,549'. Disc. new sand 14,000' Segment
15,556 14,482	Texaco #2 Lake Barre Un. 39		Lake Barre Terrebonne	10-31-59 7-24-59		14,468-82	169 b/d 30.5° 257 Mcf S-28 TP 2000	FW.
15,564 Dry	Pure Oil #3 OCS-0264 (St. Lse. 1548)		S. Timbalier Blk 20 Lafourche	3-16-59 10-20-58				FW.
15,570 14,768	Calif. Co., et al #4 St. Lse 2162		Simon Pass St. Martin	4-14-59 12-24-58		14,758-68	226 b/d 54.6° 4256 Mcf 15/64" TP 3100	FW.
15,588 Dry	Continental Oil #1 R. P. Prejean, et al	Dillard-Waltermire	Maurice (Milton) Vermilion	11-16-59 6-30-59	9.5# to 18.1# at TD			FW. 93 days to drill.
15,605 Dry	Pure Oil #1 John Siracusa		WC. St. Mary	2- 1-69 8-24-58				WC.
15,606 Dry	Pan Am. Petr. #2 St. Lse. 3258		Lake Raccourci Lafourche	8- 5-59 6- 3-59				FW. S. Extension.
15,625 15,511	Texaco #1 Lake Barre Un. 46		Lake Barre Terrebonne	7- 9-59 5-10-59		15,474-511	194 b/d 50.2° 1,432 Mcf S-32 TP 4600	FW.
15,637 15,504	Union O&G of La. #A-5 W. E. Walker	C. B. Webster	Lake Arthur Jefferson Davis	11- 6-59 2-23-59	Gyp-Q-Broxin oil emul.	15,472-504	240 b/d 41° 7280 Mcf Adj. TP 5500	FW. Hackberry sd. 130'.
15,648 TA	Wm. T. Burton Ind. #12 Simoneaux		Des Allemands St. Charles	6-20-59 6-11-55				FW. Closed in to be comp. or aban. at later date.
15,657 15,070	John W. Mecom #5 LL&E	Co. rig	Lake Washington Plaquemines	9-20-59 6- 5-59	Gyp-Q-Broxin	15,050-70	146 b/d 50.8° 1170 Mcf 9/64" TP 4600	FW. Extended Field. Disc. 29-S sd. 20'. 65 bits.
15,665 TA	Texaco #3 St. Joseph Bay Un. 1		WC. Lafourche	9-15-59 1-23-59				WC.
15,669 J&A	Superior Oil #1 Wilson Guidry	Rowan	S. Sunrise Terrebonne	10- 5-59 6-13-59	17.7# at TD			WC. 82 days to drill. 33 bits.

TABLE 6. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	1. Company 2. Well	Drilled by	1. Field or area 2. County/Parish	1. Completed 2. Spudded	Mud program	Perf. in prod. zones	1. Initial prod., gravity 2. Coke, tubing pressure	Remarks
			LOUISIANA — (continued)					
15,678 Dry	Monterey Oil #1 Avoca Inc.	Webster Drlg.	WC. St. Mary	9- 5-59 5-19-59	Byp-Q-Broxin at 9,000' 12.4#/gal at 13,500'; 16-17#/gal. to TD			WC. Fishing job from 8/13 to 9/5. 86 days to drill. 50 bits. P&A.
15,750 14,954	Placid Oil et al #2 Joseph Exposito et al Un. 1	Penrod	Lapeyrouse Terrebonne	9-20-59 7-22-59	Mud 9.9; pH 12.5 to Mud 17.8; pH 13.0	14,920-54	193 b/d 51.6° 7382 Mcf 16/64" TP 4980	FW. Extended Field in Miocene sand 109'. 55 days to drill. 59 bits.
15,750 14,768	Calif. Co.-Miss. River Fuel #4 St. Lse 2162		Simon Pass St. Martin	4-14-59 12-24-58		14,758-768	226 b/d 54.6° 4256 Mcf 13/64" TP 3100	FW.
15,783 13,566	Texaco #1 Francis McGowan		Bayou fer Blanc Lafourche	10-26-59 6-18-59		13,552-66	146 b/d 38.3° 326 Mcf S-23 TP 4300	WC. New oil disc.
15,819 10,180	Union Prod. #3 Allan Ld. Co.	Delta Drlg.	Hollywood Field Terrebonne	12-28-59 9- 9-59	Gyp. mud w/6-8% oil	10,170-80	265 Mcf 1/64" TP 1350	WC. Dry gas well. Extended field. 10170' sand. 94 days to drill. 39 bits.
15,832 D&A	Union Oil of Calif. #1 St. Lse 3319	Loffland Bros.	E. Marsh Island Prospect Iberia	4-27-59 1- 2-59	Red mud to 9,000', lime base oil emul. to TD			WC. 78 days to drill. 74 bits.
15,833 P&A	British Am Oil #D-2 R. J. Thibodeaux	Loffland Bros.	Ramos Assumption	1- 5-59 10- 7-58	Converted to lime base mud at 10,157'; Added diesel oil at 10,879. Final mud wt. 17.6#/gal.			FW. Dry hole. 77 days to drill. 50 bits.
15,837 12,180	Pan American, #1 OCS-0572		Eugene Isl.,Blk193 St. Mary	12- 8-59 10-11-59		12,168-180	24 b/d 59.6° 2800 Mcf 13/64" TP 4100	WC. New gas disc.
15,848 15,631	Shell Oil, #1 Weeks Gall Un. 6	Co. tools	Weeks Isl. Iberia	10-17-59 9-10-59	10.9#/gal. low pH Red	15,631	141 b/d 42.3° 3360 Mcf 28/64" TP 2375	DW. Miocene sd. 52'. Drilled in 31 days. 48 bits.
15,853 P&A	Frankfort Oil #1-X Lacassine Co.	Circle Drlg. & Loffland	WC. Cameron	7-22-59 4-16-59	17.8#/gal lime and gyp w/oil			WC. TA 8-30-58. Reentered 4-16-59. Dry.
15,861 Dry	Union Oil of Calif., #1 St. Lse 3319	Loffland Bros.	WC. Iberia	4-27-59 1- 3-59				WC.
15,867 P&A	Union Prod., #3 OCS 0480	Rimrock Tidelands	Eugene Isl. Area St. Mary	10-18-59 8-18-59	Seawater gyp. w/6-8% oil			WC. 45 bits. Drilled in 55 days. Dry.
15,873 P&A	Austral Oil, #1 Ralph Potter	Bullard Drlg.	Thornwell Jefferson Davis	3-14-59 11-21-58	Nat. to 8000'-lime base @/10% diesel remainder			DW. 59 bits.
15,883 15,840 15,858	Placid Oil, #1 Marie S. Wurzlow, et al Un. 2	Penrod	Lapeyrouse Terrebonne	7-23-59 4- 3-59	9.8; pH 9 to Mud 14.0; pH 10.5	15,828-840 15,844-858	206 b/d 47° 6000 Mcf 37/64" TP 5350	FW. Extended field. Miocene 83'. 88 bits.
15,900 15,627	Shell Oil, #1 Weeks Gall Un. 5	Loffland Bros.	Weeks Isl. Iberia	7-26-59 5-30-59	10.8#/gal. low pH Red	15,627	129 b/d 44.9° 3374 Mcf 28/64" TP 1300	DW. Miocene 51'. Drilled in 50 days. 43 bits.
15,971 15,838	Texaco, #133 St-Caillou Isl.		Caillou Isl. Terrebonne	9-30-59 5-22-59		15,829-838	224 b/d 31° 495 Mcf S-27 TP 3700	FW.
15,986 Dry	California Co. #1 Otis Aguillard		Jefferson Davis	12-17-59 9-17 59				WC.
15,996 14,910	Texaco #3 St. Lse 2856	Co. rig	Caillou Terrebonne	2-22-59 11- 4-58		14,878-910	129 b/d 34° 106 Mcf S-46	WC. Extended field.
16,000 P&A	Richardson & Bass, #1 Dr. J. P. Maubeules, Jr.	Dillard & Waltermire	S. Rayne Lafayette	4-26-59 10-29-58				FW. 47 bits.
16,000 Dry	Texaco, #1 OCS 0497		Eugene Is. Blk. 118 So. Mary	8-18-59 5-19-59				WC.
16,000 15,797	Texaco, #47 St. Lse 340-CBI		Cote Blanch Isl. St. Mary	7- 5-59 2- 6-59		15,787-797	216 b/d 29.8° 275 Mcf 1/64" TP 2200	FW.
16,000 15,802	Texaco, #3 Lk. Barre Un. 45		Lake Barre Terrebonne	8-16-59 5-11-59		15,794-802	192 b/d 24.9° 149 Mcf S-37 TP 800	FW.
16,004 TA	Texaco, #75-St E. Hackberry		E. Hackberry Cameron	3-10-59 11-14-58				FW.
16,005 Dry	Mobil Oil, #E-1 OCS-0469 Blk 139	Co. rig	Eugene Isl. 128 St. Mary	8- 4-59 4- 8-59	Gyp-Q-Broxin oil emul. Max. wt. 15.4#/gal.			WC. 45 bits.
16,005 Dry	Placid Oil, #1 Harry Bourg	Penrod	Dulac area Terrebonne	5-24-59 1-29-59	Mud 9.3; pH 9.3 to Mud 17.4; pH 90			WC. 85 bits.
16,006 D&A	Humble, #D-5 La Terre Co., Inc.	Co. rig	Bayou, LaCroix Terrebonne	5-28-59 3-20-59	Gyp-Q-Broxin w/E.P. add. Max. wt. 16.8#			FWC. Drilled in 67 days.
16,008 P&A	F. A. Callery, #2 E.P. Brady, et al	Brewster-Bartle	Bayou de la Fleur Plaquemines	12-23-59 8-17-59				WC.
16,008 12,527 12,832 13,128	Continental Oil, #2 OCS-0134 (St. Lse 954) GI 48 #D-1	Tidelands Drlg.	Grand Isl, Blk 47 Jefferson	6-16-59 4- 9-59	10# 5000', 10.5# 7000', 11# 11,000', 11.5# 12,000', 12# 12,500', 12,700', 12.5# 13,000-13,500'	12,522-527 12,827-832 13,122-128	378 b/d 33.4°, 246 b/d 32.8°, 285 b/d 29.2°, 1003 Mcf, 5/64" TP 2650, 2450, 4500	Extended field. Proved new production in a new fault blk on NW flk of blk 47 structure. NS sand 16', OE sand 19', OP sand 24'. Drilled in 53 days. 42 bits.
16,018 13,238 13,260	California Co.- So. Nat. Gas., #1 M. S. Nelson		Mosquito Bay (SW Ext.) Terrebonne	12- 5-59 5-17-59		13,226-238 13,251-260	3900 Mcf (Dry) 22/64" TP 2100	Extension.
16,025 15,000 15,516	Skelly Oil., #1 St. Lse 3307	Dixie Drlg.	Vermilion	9-18-59 5-29-59		14,990-15,000 15,514-516/6	36 b/d 45.2° 7750 Mcf, 17 b/d 50° 1400 Mcf 8/64" TP 7750, 18/64" TP 2300	WC. Dual gas disc.
16,032 No gge	Placid Oil., #2 OCS-0437	Penrod	Eugene Isl.Blk 199 St. Mary	3-15-59 12-28-58		Not perf.		WC. New gas disc. Offshore.

TABLE 6. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	1. Company 2. Well	Drilled by	1. Field or area 2. County/Parish	1. Completed 2. Spudded	Mud program	Perf. in prod. zones	1. Initial prod., gravity 2. Coke, tubing pressure	Remarks
			LOUISIANA — (continued)					
16,033 Dry	Gulf Oil., #1 St. Lse 3304	Kerr-McGee	Vermilion	6- 4-59 11-21-58	Wt. ranged from 9.5# to 15.6#			WC. 99 bits.
16,042 D&A	Austral Oil, #1 Miami Corp. (5910)	Bullard Drlg.	Cameron	10-10-59 6- 5-59	Nat. to 8000', Gyp-Q-Broxin remainder			WC. 56 bits.
16,055 D&A	Austral Oil- Continental Ld. & Fur #1	Hershey Drlg.	Terrebonne	6-15-59 3- 1-59	Nat. to 10,000', Lime base plus 10% Diesel remainder			WC. 57 bits.
16,101 16,006	Texaco, #1 Lake Barre Un. 45		Lake Barre Terrebonne	1-11-59 11- 1-58		15,982- 16,006	243 b/d 27.3° 298 Mcf S-31 TP 2500	FW.
16,106 12,820	McDermott, #A-1 OCS-0526	Offshore Co.	Cameron	1- 9-59 9-19-58		12,800-820	Oil 48.2° 2100 Mcf adj. TP 4950	WC. New gas disc.
16,125 14,340	John W. Mecom, #7 St. Lse 2028	Co. rig	Lake Washington Plaquemines	10-13-59 7- 6-59	Gyp-Q-Broxin	14,314-340	183 b/d 40° 772 Mcf $^{16}/_{64}$" 2750	FW. Drilled in 55 days. 50 bits.
16,133 16,115	Superior, #3 R. W. Buckley	Co. rig	Four Isle Dome Terrebonne	12-28-59 7-20-59	14.2# at TD	16,080-115	91 b/d 46.6° 4045 Mcf $^{14}/_{64}$" TP 4224	FW. Oprns suspended 8-31-59 to 10-15-59. #94 E. Seg. sd. 45'. Drilled in 95 days. 57 bits.
16,136 Dry	Grande Corp., #1 Irving E. Legendre	Co. rig	St. John area. Lafourche	6-10-59 12- 4-58	Lime base oil emul.			WC. 106 bits.
16,142 Dry	Olin Gas Trans. #3 Harrison	Doc Drlg. Corp.	Lafourche	9-23-59 6-23-59				WC.
16,152 13,853	Atlantic Ref., #18 Adeline Sugar	Fred Wilson Drlg	Jeanerette area St. Mary	9-20-59 4-24-49	Gyp OE 10#-17#	13,853	133 b/d 46.2° 2900 Mcf $^{13}/_{64}$" 4240	WC. Exten. Planulina sd. 15'. 91 bits.
16,186 Dry	Mobil Oil., #1 St. Lse 3320	Co. rig	E. Cote Blanche Bay Iberia	5- 6-59 1-13-59	Gyp-Q-Broxin oil emul. Max. wt 16.7#/gal.			WC. 65 bits.
16,195 P&A	Union Prod., #2 OCS-0480	Rimrock Tidelands	Blk 128 St. Mary	8-17-59 6-26-59	Seawater Gyp w/6-8% oil			FW. Drilled in 53 days. 34 bits.
16,208 15,920	Placid Oil, et al #1 Viguerie, et al Un. 1	Penrod	Lapeyrouse Terrebonne	2-24-59 12- 6-58	Mud 9.4; pH 8 to Mud 13.0; pH 9.9	15,900-920	245 b/d 49.8° 6700 Mcf Adj. choke. TP 4700	Extended field in Miocene 110'. Drilled in 71 days. 77 bits.
16,215 D&A	Humble O&R, #3 Lutcher-Moore	Co. rig	N. Gibson- Terrebonne	5- 8-59 1-12-59	Low solid alky tann. Max. wt. 18.2#/gal			F WC.
16,216 Dry	Sinclair O&G, #1 St. Lse 2490		Timbalier Bay Lafourche	11-23-59 7-20-59				FWC.
16,233 10,980 13,414	Superior, Rockefeller State Lse 2038, #26	Co. rig	Deep Lake Cameron	11-19-59 2-10-59	15.5# at TD	10,971-980 13,404-414	71 b/d 49.5° 4072 Mcf $^{18}/_{64}$" TP 3598, 61 b/d 48.2° 3908 Mcf $^{14}/_{64}$" TP 3804	Dual comp. Oprns suspended 76 days at TD. Moved back on and comp. New sand #67 23'. Drilled in 134 days. 87 bits.
16,238 16,178	Texaco, #2 St. Lse 3064	Brewster-Bartle	Lake Barre Terrebonne	8-11-59 5-21-59		16,153-178	262 b/d 27.9° 78 Mcf S-31 2400	FW.
16,267 16,130	Tidewater, #2 Lacassine	Clegg & Hunt	Lacassine Refuge Cameron	4-10-59 11-19-58	Max. wt. 18.5#/gal. lime base	16,112-130	228 b/d 48.2° 2600 Mcf $^{8}/_{64}$" TP 11,300	WC. New gas disc. Camerina sd. 34'. 53 bits.
16,376 15,861	Superior, #11 LL&E-St. Un. 12	Co. rig	Four Isle Dome Terrebonne	7-2 -59 3-26-59	17.2# at bottom	15,846-861	81 b/d 49.1° 5613 Mcf $^{16}/_{64}$" TP 5590 CP 1400	FW. New sd. segment #94 sd. Drilled in 89 days. 62 bits.
16,433 16,381	Texaco, #147 St. Lse 301		Caillou Terrebonne	3- 3-59 11-15-58		16,363-381	208 b/d 46° 1767 Mcf S-35 TP 4300	FW.
16,452 12,976	Union O&G of La., #2 St. Lse 2682	C. G. Glasscock	E. Lake Sands St. Mary	8-10-59 11-27-58		12,970-976	33 b/d 52.6° 1316 Mcf $^{18}/_{64}$" TP 4800	FW. Exten. field in Robulus sd. 30'. 109 bits. Union O&G took over oprns at 15,208'. 4-3-59.
16,497 11,140	Texaco, #69 La Terre Co., Inc.		Golden Meadow Lafourche	7- 9-59 10-20-58		11,131-140	133 b/d 38.9° 122 Mcf S-27 TP 1800	WC. Extended field.
16,503 Dry	Continental-Monsanto Chem., #1 Avoca, Inc.	Southeastern Drlg.	Ramos area St. Mary	2-23-59 8-27-58	9000' 9.8#, increasing to 16,000 17.6#			WC. 87 bits.
16,507 14,175	Kerr-McGee, #6 OCS-0346	Southeastern Drlg.	Ship Shoal area, Blk 28 Terrebonne	7-17-59 1-15-59	Gyp base 20.2#	14,150-175	418 b/d 54.4° 6850 Mcf $^{15}/_{64}$" FPT 4200	FW. New sd. L. Whale. 78 bits.
16,515 D&A	Hassie-Hunt Trs, et al #1 Bilello-Martinez, et al Un. 1	Penrod	Rousseau area Lafourche	10-15-59 7-18-59	Gyp Q-Broxin 18.2#			WC. Drilled in 67 days. 56 bits.
16,522 14,940 15,155	John W. Mecom, #93 E. Cockrell, Jr., et al	Cron & Gracey	Lake Washington Plaquemines	10- 8-59 4-22-59	Gyp-Q-Broxin	14,930-940 15,140-155	252 (#93-D) b/d 58 & 60° 3170 Mcf $^{15}/_{64}$" TP 1900	Dual gas well. #28 & 29 sd. 60' & 145'. 67 bits.
16,556 14,825	Texaco, #33 St. Lse 1249		Caillou Isl. Terrebonne	1-20-59 8- 7-58		14,801-825	90 b/d 52.2° 1303 Mcf S-34 TP 2650	FW.
16,562 Dry	Placid, #B-1 St. LL&E Un.	Penrod	Lapeyrouse Terrebonne	7-21-59 4-28-59	Mud 10.1; pH 13 to Mud 13.7; pH 9.5			FW. Deepened in 69 days. 62 bits.
16,679 Dry	Tidewater, #3 Lacassine	Clegg & Hunt	Lacassine Refuge Cameron	9-13-59 5-11-59	Max. wt. 18.5#/gal., lime base			WC. 50 bits.
16,681 9,290	Miss. River Fuel-Hope Nat. Gas, #3 St. Lse 3403	Co. rig	Pass Wilson (Conf) Terrebonne	10-18-59 7-27-59		9,273-90	38 b/d 51.7° 4250 Mcf $^{15}/_{64}$" TP 2700	New gas pay.
16,690 15,679	Wm. T. Burton, #2 St. Lse 2833		Lake Palourde St. Mary	9-15-59 12- 1-58		15,675-679	82.75 b/d 48.2° 4135 Mcf $^{9}/_{64}$" TP 10,375 CP 4500	FW.
16,710 15,224	Texaco, #1 St. Lse 2084 Un. 2	Two-R Drlg. Co.	Queen Bess Isl. Jefferson	11- 5-59 3-17-59		15,199-224	113 b/d 45.5° 5930 Mcf $^{15}/_{64}$" TP 3500	FW.

TABLE 6. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	1. Company 2. Well	Drilled by	1. Field or area 2. County/Parish	1. Completed 2. Spudded	Mud program	Perf. in prod. zones	1. Initial prod., gravity 2. Coke, tubing pressure	Remarks
			LOUISIANA — (continued)					
16,773 Dry	Sohio, #E-1 C. M. Thibodeaux Un.	Loffland Bros.	Ramos Assumption	7-15-59 4-22-59	9-10# to 10,500', 10.5#-13# at 13,500, 17#-17.8# to TD. High lime base 10% oil below 11,300'.			Drilled in 66 days. 53 bits. 20" conductor @ 200'; 13⅝" @ 3500'; 9⅝" @ 13,500'.
16,788 TA	Texaco, #40 St. Lac 340-CBI		Cote Blanche Isle St. Mary	10- 9-59 4-11-59				FW.
16,811 TA	John W. Mecom, #1-X LL&E	Co. rig	Terrebonne	3-17-59 7-21-58	Gyp-Q-Broxin			WC. 76 bits. Fish in hole
16,816 Dry	Sun Oil #1 LL&E	Brewster-Bartle	W. Bayou Rambio Terrebonne	11-13-59 3-17-59	Kembreak oil emul.			WC. 89 bits.
16,881 Dry	Tidewater Oil #93 Burns Levee Dist.	Rowan	Venice Plaquemines	9- 5-59 5-16-59	Conv. to high pH lime @ 9000'. Max. wt. 16.7			WC. Sdtrkd hole. Orig TD reached in 85 days. ST hole required additional 22 days. Orig. 70 bits. ST 6 bits.
16,900 16,806	Superior Oil #8 LL&E	Co. rig	Four Isle Dome Terrebonne	3-26-59 11-26-58	13.2/50/.9 @ Btm.	16,788-806	532 b/d cond. 46.1° 6803 Mcf 15/64" TP 4400	FW. New #96 sand 38'.
16,900 16,447	Texaco #1 Lk Barre Unit 39		Lake Barre Terrebonne	1-12-59 10- 7-59		16,438-47	232 b/d 46.3° 1,254 Mcf S-31 TP 4750	FW.
16,930 Dry	John W. Mecom #1 St. Lac 3326	Co. rig	Bay St. Elaine Terrebonne	5-18-59 1- 4-59	Gyp-Q-Broxin			WC. Saltwater flow @ TD. 70 bits.
17,000 Dry	Texaco #3 S/L 3005		Leeville Lafourche	3-17-59 7-17-58				WC.
17,003 TA	Placid Oil #3 OCS-0475	Penrod	Eugene Is. Blk 128 St. Mary	3- 1-59 11-12-58				FW.
17,051 Dry	Texaco #26 St. Lac. 340-Rabbit Island OCS-0310		Rabbit Is. Iberia	8-20-59 3-14-59				WC. Offshore.
17,203 15,828	Sun Oil #9 St. Lac 2620	Co. tools	Lake Pelto Terrebonne	10-28-59 4-16-59	Kembreak oil emul.	15,814-28	362 b/d 33.8° 530 Mcf ⅜" TP 4200	Pool WC. in "R" sd. 46'. 86 bits.
17,216 16,928	Union O&G of La. #1 Flavie Vincent Adams	Loffland Bros.	Leleux Vermilion	8-12-59 2-10-59	High pH lime base oil emul.	16,912-28		WC. New Camerina sd. 120'. 58 bits.
17,272 15,212	Texaco #5 Lk Barre Un. 26		Lake Barre Terrebonne	5-19-59 11-25-58		15,200-12	84 b/d 24.8° S-60	FW.
17,275 16,737	Superior Oil #2 Terrebonne Parish Sch. Bd.	Co. rig	Four Isle Dome Terrebonne	10-14-59 7- 5-59	16.5# at TD	16,715-37	172 b/d 49.0° 4215 Mcf 15/64" TP 4033	FW. 94 sd. 205'. 85 days to drill. 50 bits.
17,330 15,950	Superior Oil #10 LL&E Un. 12	Co. rig	Four Isle Dome Terrebonne	7-19-59 7- 5-58	16.4# at TD	15,934-50	92.50 b/d cond. 48.7° 5628 Mcf 15/64" TP 5600	FW. Operns. suspended from 1-10 to 5-30 then deepened.
17,395 17,260	Union Oil of Cal. et al #1 St. Lac 3324-LL&E	Dixie Drlg.	E. Timbalier Bay Lafourche	8-24-59 1-19-59	Nat. sea water to 9500'. Red mud to 12,000'. Oil emul. shale ban to TD	17,242-60	255 b/d 46.6° 5000 Mcf 15/64" TP 3800#	WC. Disc. New fld. Robulus (15) #2 sd. 28'. Drld. to 17,245', D.P. stuck, fishing job failed. Sdtrkd hole from 15,726 to 17,395.
17,436 P&A	John Mecom, et al #1 LL&E Un. 1-R	Cron & Gracey	Lake Wash. Plaquemines	4-18-59 11-27-58	Gyp-Q-Broxin			WC. Dry. Damage to casting. 74 bits.
17,446 Dry	Texaco #B-1 Terrebonne Pb. Sch. Bd.		Bayou Penchant Terrebonne	6-15-59 1-12-59				FW.
17,458 TA	Texaco #7 St. Lac 2986		Caillou Island Terrebonne	8-13-59 4- 8-59				WC. Ofishore.
17,524 D&A	Hassie Hunt Trs. #1 Remy Baudoin Un.	Penrod	Leroy area Vermilion	1-27-59 10- 4-58	Lime base 17.6#			WC. 53 bits.
17,598 17,288	Texaco #1 Lk Barre Un. 44		Lake Barre Terrebonne	12-15-59 7-11-59		17,266-88	257 b/d 34.8° S-35 TP 1300	FW.
17,616 16,548	Texaco # 5 Lk Barre Un. 38		Lake Barre Terrebonne	5- 7-59 11-20-58		16,530-48	235 b/d 42.5° 800 Mcf S-32 TP 3450	FW.
17,748 16,908	Superior Oil LL&E St. Un. H #1	Co. rig	Four Isle Dome Terrebonne	5-29-59 1-11-59	16.5# at TD	16,898-908	215 b/d cond. 50.6° 5521 Mcf 15/64" TP 4220	FW. Exten. field. New #93 sd. 37'. 81 bits.
17,788 Dry	Shell Oil #1 Kursweg-Prohaska Un. "A"	Co. tools	Ramos St. Mary	3- 2-59 11-21-58				FW.
18,000 17,580	Sun Oil Miami Corp. #2	Webster Drlg.	Belle Isle St. Mary	6- 4-59 10-21-58	Kembreak oil emul.	17,573-80	114 b/d cond. 45.1° 3200 Mcf ⅛" TP 11,300	Pool WC. Ext. Rebulus #43 sd. 35'. 98 bits.
18,126 Dry	John Mecom et al #3 Vermilion Bay Land —E. Cockrell, Jr., et al	Co. rig	Lake Wash. Plaquemines	9-26-59 2-26-59	Gyp-Q-Broxin			WC. TA. 78 bits.
18,138 Dry	Texaco #2 B.S.E. Un. 18		Bay St. Elaine Terrebonne	3-25-59 9-12-58				FW.
18,325 Dry	Richardson & Bass El Irma C. Hardee	Co. rig	Riceville Vermilion	2-22-59 10-26-58				FW. P&A. 62 bits.
20,752 15,312	John W. Mecom et al J. E. Hill #2-Q BLD-LL&E-R. Price et al St. Lac 2345 Un. 1	Co. tools	Home Place Plaquemines	9-24-59 10-23-58		15,300-14	227 b/d 38.3° ⅝4" TP 9000	FW. New oil pay. Three rigs worked on this well.

TABLE 6. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	1. Company 2. Well	Drilled by	1. Field or area 2. County/Parish	1. Completed 2. Spudded	Mud program	Perf. in prod. zones	1. Initial prod., gravity 2. Coke, tubing pressure	Remarks
			MISSISSIPPI					
15,020 Dry	Pan American #1 Stringer	Gulf Coast Drlg. & Expl.	WC. Simpson	1-23-59 10-23-58				
15,048 14,168	Tidewater #1 Mikell	Big Chief	Grange Jefferson Davis	10-16-59 6-23-59	Max. wt. 11.4#/gal. Natural-oil emul.	14,155-168	36 b/d 49.9° 2646 Mcf $^{12}/_{64}$" TP 4050	FW. Exten. 77 bits. Drilled in 83 days.
15,353 13,340	Pan American #1 Jeff Holloway	Big Chief	Grange Jefferson Davis	5-17-59 12-30-58		13,340	35 b/d 1368 Mcf	WC. New field disc.
15,445 12,393 13,143	Gulf Oil #1-ZB Soso Fld. Un. 27-10	Zach Brooks	Soso Jasper	1-18-59 9- 7-58	Fresh water, clay, low solids	12,384-93 13,143	U 324 b/d 41.6° 173 Mcf $^{17}/_{64}$" TP 1000; L 334 b/d 42.3° 156 Mcf $^{14}/_{64}$" TP 650	Dual comp. Extended fld. in Hosston. sd. 56'. 86 bits.
15,520 13,298	Gulf Oil #1-ZB Soso Fld. Un. 29-3	Zach Brooks	Soso Smith	7-17-59 2-19-59	Fresh water, clay	13,182-92	206 b/d 38.4° $^{5}/_{8}$" TP 250	FW. Exten. Drilled in 94 days. 82 bits.
15,700 Dry	California Co. #8 Central Oil "5"		Raleigh Smith					WC.
16,857 Dry	Pan American #1 Barron Smith	Larco Drlg.	WC. Jones	6- 8-59 1- 9-59				Taken over from Larco 1-19-59 at 14,251'.
			NORTH DAKOTA					
15,135 Dry	Amerada Petr. #1-A Antelope Un.		WC. McKenzie					
			OKLAHOMA					
15,564 D&A	J. M. Huber #1 Wagner	Big Chief	WC. Custer	3- 4-59 6-11-58	Gyp base			WC.
16,557 Dry	British-Am. #1 Sizemore-Phipps	Big Chief	Knox-Bromide Grady	8-13-59 1-23-59	Converted to lime mud at 10,372'. Final mud wt. 12.6/1 gal.			FW.
21,025 Dry	Grande Corp. #1 Anadarko Bas.		Anadarko Bas. Caddo	7-25-59 11-10-57	Caustic-Quebracho gel			WC.
			TEXAS					
15,000 15,000	Gulf Oil Fisher-Bonsack Un. (Gas Un.) No. 1-E	Rowan Drlg.	Puckett (Ellenburger) Pecos	4- 9-59 11-11-58	Air, salt water mud, fresh water mud	15,000	Not potentialed yet	FW.
15,001 D&A	Shell Oil #1 Continental Fee	Well Drillers	WC. Cameron	11-20-59 9- 2-59				WC.
15,005 15,005	Stan. of Texas #1 Roark, et al Un.	Delta	Puckett (Ellenburger) Pecos	10-24-59 3- 3-59	Water, gas, salt water oil emul.	15,005	9 b/d, 54.9°, 4,696 Mcf, $^{18}/_{64}$", TP 3556#	FW.
15,016 13,632	Sun Oil #1 Wangemann	C. J. Foster	Sarah White Galveston	5-14-59 11-27-58	Kembreak lime oil emul.	13,622-632	Shut-in gas well	Pool wc, disc. new Andrau #1 sand. 10'. 47 bits.
15,150 13,840	Phillips Petr. #2-A O'Daniel		Alta Loma Galveston	3- 6-59 11- 6-58	Native to 5700'. Driscose lime Q Broxin oil emul. to TD. Max. wt. 17.6#/gal.	13,825-40	562 b/d 42.3° 12,632 Mcf $^{18}/_{64}$" TP 9150	Extended fld. in "S" sd. 123'. 96 days to drill. 40 bits.
15,154 14,648	Phillips #1 McVea Un.		Alta Loma Galveston	8- 3-59 6- 4-59	Native to 7000'. Driscose lime Q. Broxin oil emul to TD. Max. wt. 17.4#/gal.	14,632-648	289 b/d 49.0° 7209 Mcf TP 9950	FW. in new Lower Andrau sd. 182'. 50 days to drill. 25 bits.
15,333 Dry	Gulf Oil Robbin A #11-E	Helmerich & Payne	Puckett (Ellenburger) Pecos	1- 1-60 6- 7-59	Gas drilling & salt water mud			FW.
15,460 Dry	Phillips Evans "A" #1	Co. rig	Alta Loma Galveston	1-26-59 11- 6-58	Native mud to 7000'. Driscose Lime Q. Broxin oil emul to TD. Max. wt. 17.4#/gal.			FW. 36 bits.
15,650 D&A	Humble O&R #1 L.R. Stone	Durham Drlg.	Stone Ranch Pecos	7- 8-59 1- 3-59	Alkaline tann. Max. wt. 10.8#/gal.			WC. D&A
15,650 Dry	Gulf Oil #1 R.W. Prosser	Great Western	WC. Terrell	7-29-59 11-11-58	Low solid, salt water mud			WC. Dry. 91 bits
15,730 10,877	San Jacinto O&G David C. Bintliff #1	Dillard-Waltermire	Bailey's Prairie Brazoria	12-24-59 8- 8-59	Gyp base w/10% diesel oil	10,867-77	20 b/d 51° 1500 Mcf $^{12}/_{64}$" FTP 1850#	WC. below 12,000. New McCarthy sd. 40'. 97 days to drill. 48 bits.
15,907 12,842	Tex. Eastern Trans. Co. #1 Sadie L. Henck		William Jack Galveston	2-18-59 10-13-58		12,834-42	4,050 Mcf BSHIP 9256	FW. New gas condensate disc.
16,000 D&A	Humble O&R #1 J. B. Malone (Hole #2)	Rowan Drlg.	Pandale Val Verde	10-12-59 3-19-59	Caustic & Quebracho lime base mud oil emul. Max. wt. 10.3#/gal.			WC. D&A. Hole #1 reached total depth 10,545' in 97 days. Hole #2 reached total depth 16,000' in 96 days. total 193 days.
16,000 6,456	Sinclair O&G #2 Houston Un.	Dillard-Waltermire	Donna Hidalgo	2-19-59 2-17-58		6,436-56	2,700 Mcf	FW.
16,024 9,250	Tex. Eastern Trans. #3 E. W. Craig et al	Gray Wolfe Drlg.	Sarah White Galveston	7- 8-59 10-25-58		9,240-50	218.34 b/d 48.1° $^{12}/_{64}$" TP 1350	FW.
16,302 D&A	Socony Mobil #1-56-C George Sealy		WC. Ward	12-15-59 10- 3-58				WC. gas drilled from 8,077 to 10,827'.

TABLE 6. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	1. Company 2. Well	Drilled by	1. Field or area 2. County/Parish	1. Completed 2. Spudded	Mud program	Perf. in prod. zones	1. Initial prod., gravity 2. Coke. tubing pressure	Remarks
			TEXAS — (continued)					
16,550 16,550	Stan. Oil of Texas Mary I. McAdams 3 #1	Falcon-Seaboard	WC. Grayson	1-25-60 5- 2-59	Lime base oil emul.	16,550	SITP 8200 psi	WC. Oil creek sd. New field. Redrilled. 81 bits.
17,051 16,264	Pure Oil #1 Houston Farms Dev. Co.	Mac Drlg.	S. Hitchcock (Proposed) Galveston	9- 4-59 3- 8-59		16,132-264	7,900 Mcf SITP 9300; BSHIP 13,800	FW. New gas condensate disc.
17,353 D&A	Pan Am. Petr. #1 Ethel Cordor	Rowan	WC. Terrell	7-10-59 11-10-58				WC. D&A.
18,550 Dry	Gulf Oil #1 Beulah McCue et al NCT-A	Falcon Seaboard	WC. Terrell	11- 1-59 9-28-58	Air drlg. & salt water mud			WC. Dry.
19,375 Dry	Sutton Prod. #6-B H. Cartwright		W. Washburn LaSalle	9- 4-59 7- 9-59				WC. Dry
23,400 Dry	Phillips-Sinclair Montgomery #1-A	Great Western Drlg.	WC. Pecos	3- 4-59 7-11-57				WC.
25,340 D&A	Phillips #1 University "E"	Co. rig	WC. Pecos	10-12-56 2- 4-59	5500-9000—diesel oil w/water w/additives as required for LC; 9000 to TD-low solids emul w/additives as required for LC.			World's deepest well. Drld. to 21,397' and lost fish; plugged back to 19,620' and whipstkd hole. Drld. to TD of 25,240'. Set 7" csg and cmtd at 22,919' in whipstkd hole.
			WYOMING					
15,835 D&A.	Pure Oil #2-A Badwater Un.		Natrona					WC.
16,248 4,942	Phillips Baggs Un. 8 #8	Kerr-McGee	Baggs Carbon	12-31-59 4-23-59	High visc., low solid, diesel oil emul.	4399-4942	1168 Mcf 1" ck. TP 250	FW. 132 bits. Extension.

TABLE 5. DEEP WELL OPERATORS IN 1959

Operator	Wells drilled 1959	Wells drilled before 1959	Total
Abercrombie, J. S.	0	1	1
Alcoa	0	2	2
Amerada	1	0	1
American Petrofina	0	1	1
Anderson-Prichard	0	1	1
Arkansas Fuel Oil	2	0	2
Atlantic Refining	4	1	5
Austral Oil Explor.	3	4	7
Belle Isle Corp.	0	1	1
Block 27 Assoc. Ltd.	0	1	1
Brazos Oil and Gas Co.	0	2	2
British American	2	16	18
Brown, Geo. A.	2	0	2
Brown, J. W.	0	1	1
Buffalo Oil	0	1	1
Burton, Wm. T., Ind.	2	3	5
California Co.[1]	7	8	15
Callery, Inc., F. A.	2	1	3
CATC	9	0	1	1
Chacahoula O&G	0	1	1
Cities Service	0	5	5
Cockrell, E. C.	9	0	1	1
Cole, H. S., Jr.	0	1	1
Columbian Carbon.	0	2	2
Continental Oil Co.	3	20	23
Denver Products & Ref.	0	1	1
Dillard & Waltermire.	0	1	1
Drilling & Explor.	0	2	2
El Paso Natural Gas.	1	1	2
Flaitz, J. M.	0	1	1
Frankfort Oil Co.	1	2	3
Ginther, Warren & Co.	0	3	3
Grande Corp.[3]	3	5	8
Gulf Oil Corp.	15	40	55
Hawkins, H. L.	0	1	1
Houston Oil	0	1	1
Huber, J. M. Corp.	1	0	1
Humble Oil & Ref.	7	50	57
Hunt Group	6	16	22
Husky Oil	0	1	1
Kerr-McGee	1	1	2
LaGloria Corp.	0	1	1
Lamson, Bennett & Cole	0	1	1
Little Nick Oil Co.	0	1	1
Lloyd Corp.	0	5	5
Lone Star Producing	1	2	3
McDermott, J. Ray	1	2	3
Mayfield, M. L.	0	1	1
Mecom, John W.[2]	9	29	39
Mississippi River Fuel.	1	3	4
Mobil Oil	3	35	38
Monsanto (Lion)	0	2	2
Monterey Oil Co.	1	3	4
Mountain Fuel Supply	0	1	1
Ohio Oil Co.	0	1	1
Olin Gas Transmission	1	3	4
Owen, J. P.	0	2	2
Pacific Western	0	1	1
Pan American	10	47	57
Pano Tech Explor.	0	1	1
Pasotex Petroleum	0	1	1
Phillips	6	36	42
Placid Oil Co.	13	20	33
Pray, Max	0	3	3
Pure Oil Co.	4	7	11
Quintana	1	1	2
Republic Natural Gas.	0	1	1
Richardson & Bass.	4	30	34
Richfield Oil	1	2	3
Rutter & Wilbanks Bros.	0	1	1
San Jacinto O&G	1	0	1
Shell Oil Co.	8	63	71
Shoreline Drilling	0	1	1
Sinclair	4	6	10
Skelly	1	1	2
Sohio	1	0	1
Standard of Calif.	1	18	19
Standard of Texas[1]	2	2	4
Sun Oil Co.	9	20	29
Sunray Mid-Continent	2	7	9
Superior Oil Co.	11	37	48
Sutton Prod. Co.	1	0	1
Tennessee Gas Trans.	0	1	1
Texaco	45	127	172
Texas Eastern Trans.	2	1	3
Texas Gas & Gasoline	0	1	1
Texas Gulf	0	2	2
Texas Pacific C & O	0	1	1
Thayer, David S.	1	0	1
Tidewater Oil	5	20	25
Trahan, J. N., Drlg.	1	0	1
Trunkline Gas-Cyprus.	0	1	1
Union of California	5	17	22
Union Oil & Gas of La.	5	13	18
Union Producing Co.	3	6	9
Vasen, George	0	1	1
Western Natural Gas.	0	2	2
Zapata Petroleum	0	1	1
TOTALS	228	793	1021

[1]Standard of California subsidiary. [2]Includes Mecom & Freeport wells. [3]Formerly Howell & Howell.

TABLE 8. DEEP WELL DRILLING CONTRACTORS FOR 1959

Big Chief Drlg. Co. Okla. City, Okla.	**Falcon-Seaboard** Tulsa, Okla.	**Kerr-McGee** Okla. City, Okla.	**Rocky Mtn. Drlg.** Los Angeles, Calif.
Brewster-Bartle Houston, Tex.	**C. J. Foster Drlg. Co.** Richmond, Tex.	**K. L. Kellogg & Sons** Compton, Calif.	**Rowan Drlg. Co., Inc.** Fort Worth, Tex.
Zach Brooks Drlg. Co. El Dorado, Ark.	**Gordon Drlg. Co.** Lake Charles, La.	**Kelly Drlg. Co.** Houma, La.	**Sea Drlg. Corp.** New Orleans, La.
Bullard Drlg. Co. Houston, Tex.	**Gracey-Hellums** Houston, Texas	**Larco Drlg. Co.** Jackson, Miss.	**Sharp-Gulf Drlg. Co.** New Orleans, La.
Circle Drlg. Co. Lake Charles, La.	**Great Western Drlg. Co.** Midland, Tex.	**Loffland Bros. Co.** Tulsa, Okla.	**Southeastern Drlg.** Dallas, Tex.
Clegg & Hunt Houston, Tex.	**Grey Wolf Drlg. Co.** Houston, Tex.	**Mac Drilling Co.** Houston, Texas	**Thirteen Drlg. Co.** New Orleans, La.
Cron & Gracey Corp. Houston, Tex.	**Gulf Coast Drlg. & Expl. Co.** Jackson, Miss.	**Nicklos Drlg. Co.** Houston, Texas	**Tidelands Drlg. Co.** Corpus Christi, Tex.
Delta Drlg. Co. Tyler, Tex.	**Gulf Marine Drlg., Inc.** Morgan City, La.	**Norton Drlg. Co.** New Orleans, La.	**Two-R Drlg. Co.** New Orleans, La.
Dillard-Waltermire Wichita Falls, Tex.	**H. E. T. Drlg. Co.** Houston, Tex.	**Noble Drlg. Co.** Tulsa, Okla.	**J. D. Ward Drlg. Co.** Lafayette, La.
Dixilyn Drlg. Co. Odessa, Tex.	**Winn Hawkins** Houston, Tex.	**Offshore Drlg. Co.** Baton Rouge, La.	**C. B. Webster Drlg.** Houston, Tex.
Doc Drlg. Co. Golden Meadow, La.	**Helmerich & Payne** Tulsa, Okla.	**Penrod Drlg. Co.** Dallas, Tex.	**Well Drillers, Inc.** Houston, Tex.
Drilling & Expl. Inc. Los Angeles, Calif.	**Hershey Drlg. Co.** New Orleans, La.	**Producers Drlg.** New Orleans, La.	**Wheless Drlg. Co.** Shreveport, La.
Durham Drlg. Co. Midland, Tex.		**Rimrock Tidelands, Inc.** New Orleans, La.	**Fred Wilson Drlg. Co.** Lafayette, La.

reach 15,300 ft in Weeks Island. Shell had the low record of 34 days drilling time in 1958, made in the same area.

Three other deep wells were drilled in under 40 days. Shell drilled another Weeks Island producer in 31 days, also with company tools. Penrod Drilling Company completed a dry development well in Lake Washington for Placid Oil Company in only 38 days.

Dixilyn Drilling Corporation drilled a wildcat that reached 15,120 ft in 38 days. It was a Shell Oil project offshore and found the first oil sand in the area.

Phillips' Alta Loma well, which made a low bit record, also made a new low drilling time for Texas. Previous record for below 15,000 ft was 61 days but this well took only 50 days to drill.

Mississippi got a new low drilling time. Big Chief Drilling Company took only 83 days to drill Tidewater's No. 1 Mikell in Grange field below 15,000 ft. Wells for the state last year showed great improvement in drilling time.

Oklahoma has a new record drilling time for deep wells, also. Last year J. M. Huber's No. 1 Wagner in Custer County went to 15,564 in 165 days. Big Chief did the drilling. Previous record was 202 days. (The same well made a new low bit record of 128 bits.)

Operators

Texaco again leads in number of wells drilled. This one company drilled 45 of the super-deep projects and now has a total of 173 such wells on record, only operator yet to go over the 100 mark and the company will doubtless pass 200 next year.

Shell is second with 72. Others who have drilled a substantial number of the deep ones are: Pan American, Humble, Hunt Interests, including Placid Oil, Gulf, Superior, Phillips, John Mecom, Mobil Oil, Richardson and Bass. (See Table 5.)

There are now almost a hundred operators that have drilled 15,000 ft or more—98 to be exact. For this year alone 51 ventured into deep drilling. Few of these are subsidiaries. Operators include a number of combines.

What of the Future?

Never have deep drilling prospects looked better. Every year has shown an increase in deep wells since 1950 and the last two years have indicated the cost crest has passed.

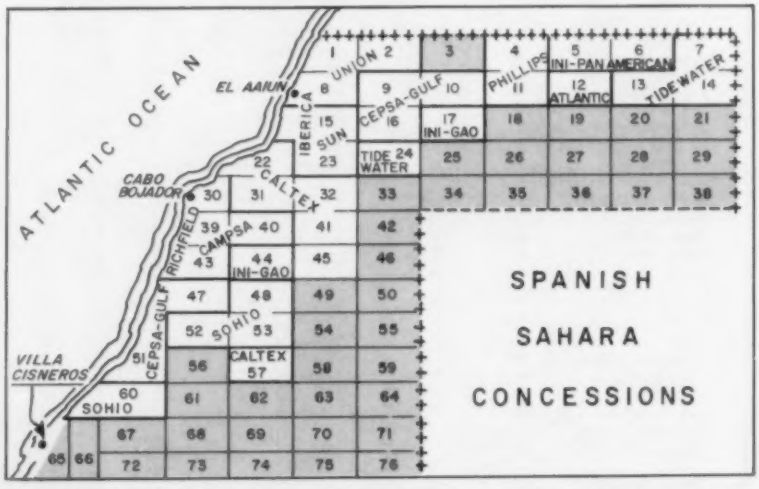
When you realize you are probing some 3 to 5 miles down with a device as small as a bit, it's surprising how successful these deep wells are — at least successful in finding oil, condensate and gas, whether the production is economically feasible. Sometimes a deep field pays out. The 37 percent increase in deep fields last year — from 35 to 48 — is an encouraging record.

Almost exactly half the 1021 wells drilled 15,000 ft or below were completed as producers and 154 of these produced from depths of 15,000 to 20,745 ft. In Louisiana 54 percent of 759 deep wells drilled have been completed as producing wells.

Like the man said — we've learned it's there when we need it. We've learned we can get deep production if the price is high enough.

The next thing — and figures indicate we're going in that direction — is to bring deep production into a more competitive position. ★ ★ ★

Spain Assigns Blocks in New Area



Ten Spanish and American companies are prepared to search for oil in the potentially rich Spanish-Sahara territory in West Africa. The companies, which recently got concessions (see map) will invest about $15 million a year on exploration. If results are encouraging this amount will be expected to rise rapidly as it has in Libya and French Algeria/Sahara (See Page E-2).

The 1958 Spanish oil law opened its Sahara to foreign investment. Thirty-six blocks, each about 600,000 acres, were awarded. Caltex won 6 blocks, the largest number to one company. Standard Oil of Ohio has 5 and Tidewater, in partnership with the Urquijo Spanish banking group, received 4 blocks. Other awards include: Gulf Oil with Spanish Cepsa, 5; Union Oil with Fierro banking interests, 3; Cun-Pure-Champlin-Fierro, 2; Richfield-Cities Service with Spanish Campsa, 4; Phillips 2; Atlantic, 1.

It is interesting that INI, Spanish government state monopoly, was awarded only 4 blocks, which seems to mean foreign companies will get equal consideration. This will doubtless do much to spur development by U. S. companies.

Nee Anadarko Basin No. 1, Now No. 1 Miller-Long Unit . . .

REBIRTH OF A DEEP WELL

The search for deep production is resumed in Oklahoma's Anadarko Basin after costly misfortune thwarted first attempts at this deep test

Lowell A. Murphy, *Assistant Editor*

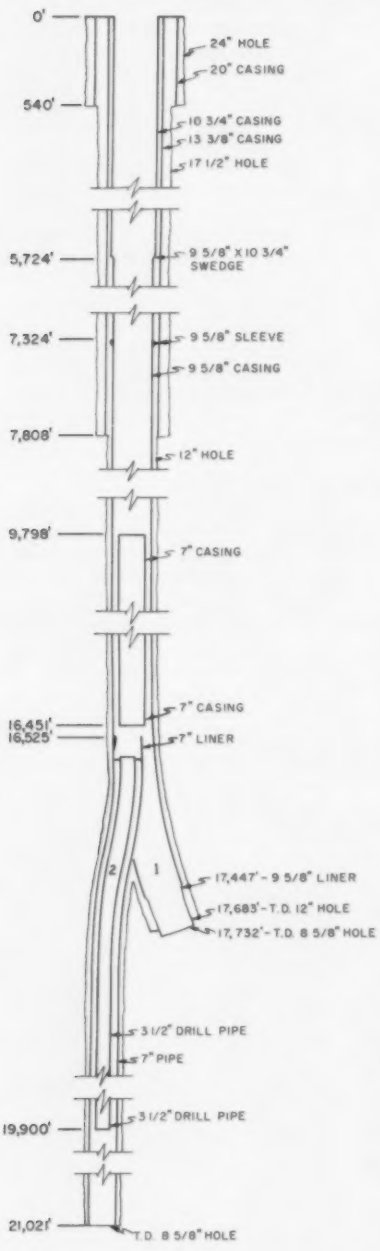
AS DRILLING GOES DEEPER, accompanying problems and expenses usually go up exponentially. A mishap which would be relatively inconsequential at 2000 ft can become of grave importance if it occurs at 20,000 ft, resulting even in forced abandonment of the drilling project.

A series of such mishaps led to the recent temporary suspension of activities at the Anadarko Basin No. 1 in Caddo County, Oklahoma, a well which had been drilled to within less than 150 ft of its originally projected target of the Bromide sand at approximately 21,150 ft. Now, however, the well, renamed No. 1 Miller-Long Unit, is the site of new operations designed by Kenneth A. Ellison, Oklahoma City independent, to bring new life to this significant deep test.

Initial Operations

The Anadarko Basin No. 1 was spudded on November 10, 1957, with a giant rig owned by Howell & Howell (now the Grande Corporation), Dallas, Texas, producers and drilling contractors. Owners of the project were

This big rig, Parker Drilling Company's No. 57, has taken over operations in this second attempt to find deep production in the Anadarko Basin of Caddo County, Oklahoma.



Original hole, the Anadarko Basin No. 1, was drilled to a total depth of 21,021 ft. The second hole (left) was started when the bit cut through the 9⅝-in. casing while drilling through a bridge in the casing. As a result, approximately 1200 ft of the first hole was lost.

Present operations began when a sidetracked hole was kicked out at 16,425 ft in the well, renamed the No. 1 Miller-Long Unit. This new hole (No. 3) was drilled to 16,560 ft before an unsuccessful fishing job forced the decision to abandon this hole and to set another whipstock at approximately 16,375 to start another sidetracked hole.

Howell & Howell, Tekoil Corporation, Gulf Oil Corporation, and Kenneth A. Ellison & Associates.

A 24-in. hole was drilled to 541 ft and cased with 20-in. welded line pipe. Drilling then proceeded in 17½-in. hole to 7903 ft and the hole was cased with special-order, 13⅜-in., N-80 casing weighing 85 lb per ft. Next, 12-in. hole was drilled to 17,683 ft and 9⅝-in., P-110 casing was run as a liner from 7324 to 17,447 ft on July 15, 1958.

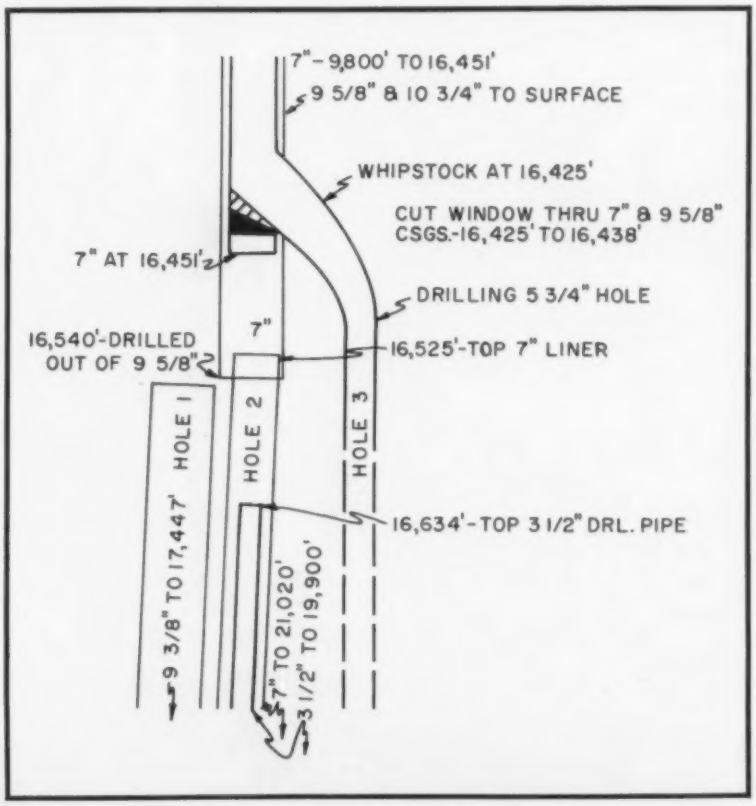
Gas breakthrough. As drilling was progressing at 17,732 ft in 8⅝-in. hole, gas broke into the hole from behind the 9⅝-in. liner. A squeeze cement job was performed at the bottom and the top of the liner, shutting off the gas. After the liner was cleaned out, it was decided to extend the liner in a full string to the surface. This was done using 5724 ft of 10¾-in. casing and 1600 ft of 9⅝-in. casing tied in with a sleeve to the top of the liner at 7324 ft.

On going back into the hole to drill ahead in 8⅝-in. hole, a bridge was encountered at 16,540 ft. While drilling on this bridge, the bit drilled out of the 9⅝-in. casing. Consequently, the original hole was lost from 16,540 to 17,732 ft, and a new hole was drilled from 16,540 ft to a new total depth of 21,021 ft. At this point, it was estimated that the hole was only 100 to 150 ft above the objective Bromide sand.

Seven-inch casing was then run as a liner from 21,020 ft back up into the 9⅝-in. casing string. However, the top part of the 7-in. liner parted at 16,525 ft, leaving 7-in. liner extending from 16,525 to 21,020 ft on January 20, 1959. During attempts to squeeze cement behind the liner with a 3½-in. drill pipe, a packer failure at 19,900 ft allowed cement to be pumped up the annular space between the drill pipe and the casing, leaving the drill pipe cemented in the hole from 15,200 to 18,800 ft.

Wash-over operations were begun and were successful in removing the 3½-in. drill pipe from 15,200 to 16,606 ft. However, it became extremely difficult to wash over the pipe inside the 7-in. liner below 16,525 ft and it was decided to halt attempts to drill deeper and to test upper sands.

Production tests. The lowest member of the Springer sand was tested through perforations in the 9⅝-in. casing. Before further testing, 7-in. casing was run from the surface to a depth of 16,451 ft. The Springer and Morrow sands were then perforated and tested, producing dry gas of insufficient volume for commercial production.



On August 25, 1959, the well was abandoned and 9800 ft of 7-in. casing was pulled.

Present Operations

Since abandonment of the hole, operations have been taken over by Kenneth A. Ellison with Parker Drilling Company, Tulsa, as drilling contractor. Other working interests in the project are held by Northern Natural Gas Producing Company, Tekoil Corporation, Mineral Mining Company, Foster-Reiter Corporation, Bradley Producing Corporation, and K. A. Ellison Associates.

Work was resumed at the site on December 15, 1959, when the cement plug at the surface was drilled out. After squeeze cementing a split in the 10¾-in. casing from 506 to 530 ft, the hole was washed down, milled through a bridge plug at 15,052 ft, and then washed down to a packer at 15,126 ft. Attempts to recover this packer were unsuccessful and it was milled up with a flat-bottom mill. Three other packers which had been set in the hole for previous tests of gas-bearing sands were milled up at 15,346 ft, 15,354 ft, and 16,120 ft. Cement, a cement retainer at 16,467 ft, and junk were milled up before a whipstock was set with the top of the tool at 16,425 ft.

Sidetrack. A diamond head and core barrel were used to cut a window through the 7-in. and 9⅝-in. casings at 16,425 ft. After cutting 20 ft, the core barrel was pulled and found to contain two pieces of pipe — slivers that had been cut from the two casing strings. In addition to the window in the casing strings, the core head had cut 7 ft of formation outside the pipe.

The diamond head and core barrel were run back into the hole and cut from 16,445 to 16,457 ft, recovering 6 ft of gray sand and sandy shale and 2 ft of shale. Drilling was then resumed with a three-cone rock bit.

After drilling had passed 16,560 ft, hole conditions began to cause new problems. Sloughing shale required frequent mud conditioning. Drilling had to stop periodically while the hole was circulated clean. Gas entering the hole increased, being circulated out continuously with the mud. Then, on February 3, two drill collars and the bit were left on the bottom of the hole.

Fishing job. Fishing operations were begun on the following day with a spear and set of jars in an attempt to recover the drill collars and bit. However, these fishing tools were also lost in the hole, leaving the top of the fish at 16,440 ft, or just outside the whipstock. After further attempts to retrieve this junk were unsuccessful, it was decided to set another whipstock at approximately 16,351 ft to start another sidetracked hole.

Difficulties in the first whipstocked hole are believed to have resulted from the rather abrupt angle at which the window was cut. The diamond head used to cut the window also cut away part of the deflecting surface of the whipstock, increasing the angle of deflection to a point that caused the drill collars to fail.

The window at the second whipstock will be cut with a regular mill and then the hole will be extended with a diamond head and core barrel.

Drilling Program

Present plans call for continuing the 5¾-in. hole through the second whipstocked hole to an approximate depth of 19,600 ft to test the Hunton limestone (Devonian). Before reaching this objective, the new hole will have drilled through the Goddard shale, and the Chester, Mayes, and Woodford formations. Drilling will proceed using a combination of conventional roller bits and diamond bits.

If drilling is progressing without too many problems when the hole reaches the Hunton limestone, the operators may decide to take the hole on down to test the Bromide sand at approximately 21,150 ft.

The hole is being drilled with a common water-base mud, treated with caustic, quebracho, and lignite. Weight of the mud has been held at around 9.5 lb per gal, with a viscosity of approximately 80 sec. So far, no special equipment has been required to handle the entrained gas.

Upon completion, the new hole will be cased with a 4½-in. liner.

Rig Specifications

Parker Drilling Company is using an electric rig, No. 57, to drill the No. 1 Miller-Long Unit. The main power plant consists of three generator sets driven by three 500-hp engines. The drawworks has an input horsepower rating of 1300.

Two 7¾-in. by 18-in. slush pumps, each rated at 600 maximum input hp at 60 strokes per min, are driven from the main power plant. Another pump, 7¼-in. by 12-in., has a rated maximum input hp of 220 at 70 strokes per min, and is driven by its own engine.

Three blowout preventers are provided for the rig. Two are ram-type preventers and the other is a doughnut-type preventer.

The rig is topped off with a 136-ft standard derrick.

Conclusion

If production is found in the No. 1 Miller-Long Unit, it is anticipated that it will be gas-condensate . . . and it will be the result of the determination and hard work of these men who are willing to take another chance at this once-abandoned deep test. ★ ★ ★

Harry N. Stansbury

Wayne C. Moody

Tom B. Campbell

W. R. Johnston

API Honors Four Engineers at Dallas Meet

CITATIONS FOR SERVICE were awarded four engineers by L. E. Fitzjarrald, API vice president of Production, at the Southwestern District meeting just concluded at Dallas, Texas. Recipients were Harry N. Stansbury, The Atlantic Refining Co., Dallas; Wayne C. Moody, Sunray Mid-Continent Oil Co., Midland; Tom B. Campbell, J. P. (Bum) Gibbins, Inc., Midland; and W. R. Johnston, Aspen Drilling Co., Albuquerque, N. M. Stansbury's award was for outstanding service as chairman of the API group which compiled "Oilwell Cementing Practices in the U. S."; Moody was acknowledged for his leadership in standardization committee work, specially on subsurface pumps; the Johnston citation was for conspicuous service as 1957-58 API district chairman; and Campbell was honored as 1957-58 district vice-chairman and as chairman of 1959 Registration Committee.

Effects and determination of . . .

Elevator and Tool Joint Wear

W. A. Wilson,
President
Web Wilson Oil Tools, Inc.
Los Angeles, California

Worn elevators and tool joints comprise an extremely dangerous link in any hoisting system. Here is a sensible plan for determining the degree and effects of wear

IF ONE WERE TO examine critically all oilfield elevators in use today, probably more than one-half would be found unsafe if operated at their rated API capacities. Still another shocking percent would be questionable at half their rated capacities, while some would be labeled unfit for use at all! Yet day in and day out all of these elevators are being used, and the ones that are safe today may tomorrow step across that fine dividing line.

Why is this so? What happens to cause these ingenuously engineered tools to become potential killers? The answer is plain and simple: wear. Many of the unfortunate accidents through the years can be attributed to elevator wear — unnoticed and unchecked. It behooves our industry, therefore, to face this problem squarely and firmly.

The Problem

Because wear constantly saps and weakens hoisting equipment — in particular elevators — this equipment should be inspected with accurate instruments and the results evaluated with competent data. For most users of elevators, standards are needed to provide for the safe and gradual retirement of their equipment.

How Wear Affects Elevators

When an elevator picks up a string of pipe, the load is transferred to the elevator at the supporting shoulder or taper, and this load travels through the various elevator parts to the link arms where it is passed on to the supporting links. It would seem from this elementary analysis that the weight of the string of pipe is the total load that the elevator is required to carry. Not so. Impact loading, for example, is usually calculated at twice the dead weight of the string. Also, the wedging action of bottleneck pipe causes the critical parts of taper-type elevators to carry loads several times greater than this dead weight. Of course, modern elevators are designed to withstand these varying loading conditions safely. The many points of force, caused by loading, have been precalculated and the elevator engineered within specific safety factors to achieve an equilibrium.

However, because the loading of an elevator is dependent upon its dimensional stability, this tool becomes dangerous when it is permanently deformed.

As link arms wear, the strength of the cantilever beam is reduced. Naturally these arms are designed with reasonable and even generous factors of safety, but wear cannot be adequately compensated for. Since alloy steels are not easily welded with good reliability, worn link arms should not be rebuilt or repaired. Rather, excessive link arm wear should signal retirement to lighter service.

Hinge pin, latch pin, and socket wear increase the bending load in these pins which makes them more subject to a progressive or fatigue failure. Wear in these areas, once started, generally progresses rapidly because of the flexure of the pins. A failure of either hinge or latch pin can result in a failure of the elevator.

Collar-Type Elevators

Square shoulder elevators in heavy use will wear or "brinnell" under the repeated loads of the tool joint or collar. During drilling operations, the square shoulder of both the elevator and the tool joint gradually becomes rounded and offers less supporting area. If this peening of the elevator load-bearing surface is allowed to continue unchecked long enough, the bore will be reduced by the gradual flow of metal until the elevator is difficult to close and lock around pipe.

At the same time, the worn surface of both the tool joint and the elevator may contact on a slight taper which could cause extreme opening forces within the elevator. That this condition could exist is admittedly rare, but indifference to wear could allow it to happen, and the result would be a catastrophe. Worn or damaged square-shoulder surfaces of elevators and tool joints are easily corrected by properly machining these surfaces.

Taper-Type (Bottleneck) Elevators

A condition that is by no means rare is the dangerous wear of 18-deg taper elevators and their counterpart, the 18-deg tool joint. As the tool joints wear due to contact with the sides of the hole and the action of the drilling fluid, the 18-deg taper tends to round off and, like the square shoulder joint, presents less contact area to the supporting taper of the elevator. The elevator taper, as a result, will begin to recess into the bore so that a cylindrical surface of approximately the outside diameter of the tool joint will form directly above the worn taper. Since all tool joints do not wear at exactly the same rate, some will be slightly larger than others. As the tapered bore recesses deepen, an occasional large joint will be forced to wedge itself down in the cylindrical surface so that the wedging or spreading force may be that of a 2 or 3 deg angle instead of the 18 deg.

Such a spreading force will far exceed any safety factor that the elevator designer could reasonably use. Yet, this wear condition in its early stages is common. Frequently it results in an elevator sticking to the tool joint. Elevators that show hammer marks around the top of the bore should be closely examined to determine whether it is the elevator, the tool joint, or if both are at fault. Although the taper may appear to be true (18 deg), the entire load bearing surface should be checked for variations.

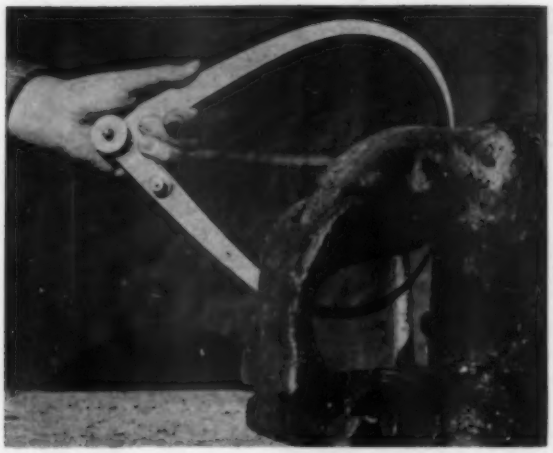


FIG. 1. **Link-arm wear** is measured with calipers and rule. Since link-arm wear is seldom rapid and somewhat uniform, the amount of wear can usually be used as a convenient yardstick for predicting service life of the elevator.

William A. Wilson, *president of Web Wilson Oil Tools, Inc., was graduated from Stanford University in 1936 with a major in mechanical engineering. His curriculum included petroleum engineering and geology. In 1937, he completed a year of post-graduate work with emphasis on machine design and stress analysis.*

Later in 1937, he went to work for Web Wilson Oil Tools, Inc., as an engineer. He continued in this capacity, in addition to outside consultant work, until 1942 when he entered active duty in the United States Army, Ordnance Department, Procurement Officer. He was discharged in 1945 as a captain.

Upon his return to Web Wilson, he was elected vice president in charge of production. In 1953, he succeeded to the presidency of the company.

He has served as secretary and president of the Nomads, and has headed subcommittees and committees of the API, as well as the Petroleum Equipment Suppliers' Association. He is currently a member of the API Subcommittee on Recommended Practices for the Care and Handling of Hoisting Equipment.

Tool Joint Rebanding

Careless rebanding and welding on tool joints can also cause rapid elevator wear that could produce a dangerous load situation quickly. Careless rebanding refers to any banding that intrudes on the 18-deg taper of the tool joint. Banding in this area is very rough. It can rapidly wear out the elevator bore and result in extremely high internal loading. If the addition of "fingers" extending down the 18-deg taper area is deemed absolutely necessary, then the welding should be performed as carefully as possible. It is important to make certain that the 18-deg taper is maintained by keeping these abrasive fingers flush with the taper. Even then the operator must be prepared for the rapid deterioration of the elevator bore.

How to Measure

It is obvious that visual inspection cannot suffice for most elevator checks. To measure link arms it is necessary to use calipers and to read the result on a rule. Since significant wear is restricted to the top link arm, it is here that the measurement is taken (Fig. 1).

Hinge pins, latch pins, and socket holes are not normally measured for wear in the field. When it becomes apparent that the hinge or latch pins are loosening, the elevator should be sent to the factory for a general engineering check-up.

For square-shoulder elevators, a rule marked in sixteenths of an inch is adequate. The straight edge of the rule is used to check the squareness of the top bore, and the end is inserted into the worn pockets and ridges. Wear of 1/16 in. or more should require refacing of collar surface. The squareness of tool joints (where collar meets the pipe) may be checked using the right angle formed by the rule end. Joints out of square by 1/16 in. or more should be reconditioned or replaced according to recommendations of manufacturer.

Determining wear of the 18-deg taper elevator and tool joint is more difficult. As shown in Fig. 2, an arm containing a true 18-deg surface is extended into and matched against the elevator bore. At the top of the bore, the actual angle is read off a protractor attached to a straight edge. The same principle is used for tool joints (Fig. 3). Here the straight edge is placed on top of the tool joint and the true 18-deg surface is placed along the tool joint taper.

Since these tapers do not wear evenly, it is necessary to use the smallest angle of contact found.

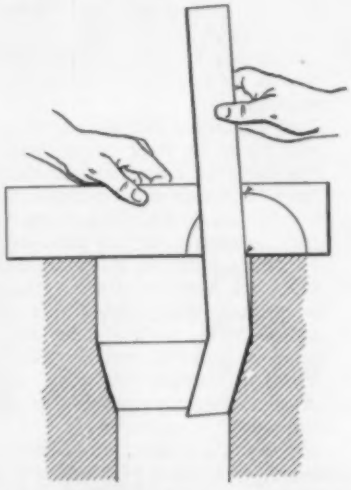


FIG. 2. **To measure elevator taper,** a true 18-deg surface is inserted on an arm into the elevator bore and matched against the taper. Result is read on a protractor attached to a straight-edge.

Inspection Gage

Recognizing the importance of an accurate measurement and appreciating the difficulty in constructing an instrument as described, Web Wilson Oil Tools, Inc. has engineered and manufactured a permanent aluminum gage (Fig. 4). This instrument permits many measurements and calculations without reference to supplementary data.

Evaluation of Wear

Once the degree of wear has been ascertained, the evaluation is conducted as follows:

From Fig. 5, determine percentage of rated capacity to which elevator loading must be reduced in order to preserve original safety factor, for var-

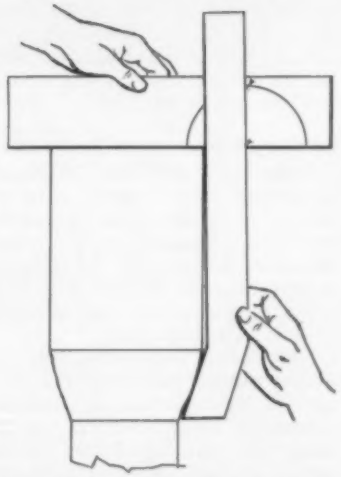


FIG. 3. **To measure tool-joint taper,** a true 18-deg surface is matched against the taper and the result read on a protractor mounted on a straight-edge at the top of the tool joint. Hardbanding should also be checked for violation of this taper.

FIG. 4. **Elevator and tool-joint inspection gage** measures amount of wear of load-bearing surfaces. Gage calculates percentage to which rated elevator capacities should be reduced, total weight of any given string, and actual bearing load conditions for elevators. Reference charts are contained on back side.

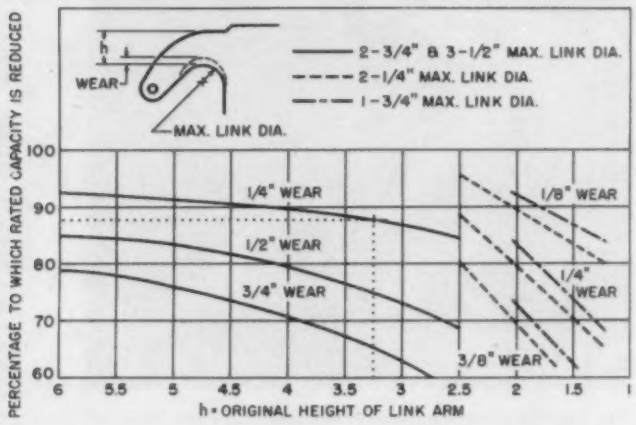


FIG. 5. **Reduced elevator capacity** due to worn link arm is expressed in terms of percentage of rated capacity in this chart. To use chart, locate amount of arm wear on line corresponding to original link-arm dimension. Percentage is read from vertical column at left.

ious amounts of link arm wear. Example: 100-ton elevator with *original* link arm height ("h") of 3¼ in. was found to have worn ¼ in. As shown by dotted line on the chart, this elevator should be rerated to 88 percent of its capacity, or 88 tons.

The effect of wear on 18-deg taper elevators and tool joints may be determined by using Fig. 6. Entering chart at *actual angle of taper*, read across to diagonal reference line and down to base of chart. Result is the percentage to which an elevator capacity is reduced by such worn tapers. Example: Inspected tool joint was found to have a taper of 13 deg. As it was to be used with a perfectly sound 250-ton elevator, the elevator capacity was reduced to 77 percent, or 192 tons.

Care and Inspection Procedures

Since both care and inspection procedures depend largely upon the amount of service the equipment has had, it is difficult to project overall recommended practice. The following is suggested as a starting point from which companies may vary according to their individual needs.

(A) Before each round trip: All elevators should be examined to determine if the latch and the latch-lock mechanism are functioning properly. Hinge pins, latch lug surfaces, and link contact surfaces should be lubricated. Slip-type casing and tubing elevators should be checked for sharp dies and the slip segments removed for cleaning and lubrication.

(B) Semi-annual check: This examination, as outlined below, whether conducted in the field or shop, should be made using calibrated instruments to determine any deviations from the manufacturer's technical data for original parts. Results are correlated with charts in Fig. 5 and 6.

1. Square shoulder collar-type drill pipe, casing, and standard tubing elevators: Inspect the collars for squareness, and uniformity and depth of wear. Uneven wear, or worn recesses of 1/16 in. or more, requires refacing of collar surface. Top link arms should be measured and the amount of wear checked against chart, Fig. 5. Hinge pins and springs should be carefully inspected visually for excess wear and obvious weakness.

2. 18-deg taper-type elevators: Inspection is the same as for square shoulder, except that the conical bore should be observed and measured (in many instances this check should be more frequent.) All tool joints used with these elevators should also be measured. Amount of wear should be checked with chart, Fig. 6. In addition to the angle of taper, hardbanding should be checked to see if it extends beyond the taper. Any straight edge may be used for this purpose.

(C) Annual review: It is further recommended that a card index of all hoisting equipment be kept which would record a permanent history of such equipment. This requires that each piece be identified by a serial number. Case histories should be reviewed annually so that elevators can be rerated or returned to the factory for reconditioning.

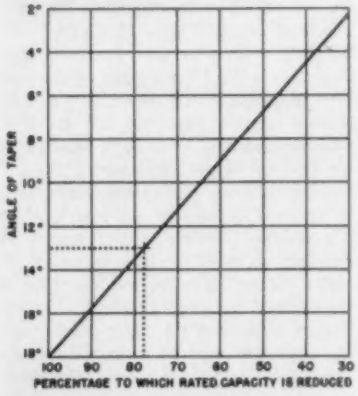


FIG. 6. **Percentage** to which elevator capacity is reduced by wear of elevator and tool-joint tapers is shown in this chart. To use chart, locate actual angle of taper at left, read across to diagonal reference line and down to percentage at base of chart.

Summary

Indifference to or ignorance of wear and its effect on hoisting equipment can lead only to additional serious accidents in the future. Elevators, in particular the 18-deg taper type, and the 18-deg tapered tool joint, should be carefully inspected for deviations from original specifications.

As wear is detected, the results should be evaluated, and the equipment retired to lighter service as good engineering practice dictates. A systematic inspection procedure should be adopted to achieve this goal. ★ ★ ★

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Gas-Condensate Reservoirs

Part 8, concluding a comprehensive series on gas-condensate reservoirs, evaluates the return to the operator by continuous operation and considers the possible value of the property to a proposed purchaser

William C. Goodson
Republic Natural Gas Company
Dallas, Texas

IN THIS CONCLUDING PORTION, an economic analysis will be made to illustrate a comparison of the three basic contracts under consideration — 15 cents per Mcf interstate, 20 cents per Mcf interstate, and 10 cents per Mcf intrastate — during their entire life of operation. The same reserve under the same contract stipulations will be evaluated by a potential buyer to arrive at a proposed purchase price having the same knowledge of the properties as the operator. A graphic presentation of this evaluation will be made suitable for management's consideration.

In the previous installments of this article, most of the geological, land, drilling, producing, processing, deliverability, regulatory, tax, and other legal matters have been discussed. We have followed the development of this property from initial geophysical and geological work, through leasing of the acreage, drilling and completion of the wells, determination of saleable reserves, contracting of the developed gas, design and installation of the gathering and field processing system, consideration for a gasoline plant, deliverability and availability studies over the life of the field, possibilities for unitization, determination of the fair market value, as well as all aspects of taxation, risk, and financing a venture of this type.

Only one aspect remains and that is to quantitatively evaluate and tie together all these facets into one package. To arrive at a value of this composite reserve package, full attention must be given to all the items mentioned in the previous paragraph. For the purposes of this article, two basic considerations will be taken up herein: (1) Operation of the property by the discoverer and developer, and (2) Possible sale to an outside interest in possession of all the information available to developer.

Before going fully into the quantitative determination of these two basic considerations, some basic compound interest curves will be discussed that will be used in these calculations and should prove of value to any future valuations the reader may be called on to make. The four curves are, as titled, "Present Worth of Future Earnings" with the interest converted semi-annually. (These curves were originally presented by the author at the School of Gas Technology, Kilgore, Texas, in October 1958.) As stated in Part 7, (THE PETROLEUM ENGINEER, January 1960) this compounding period is a compromise but is used somewhat generally.

The four curves are broken into two parts — an annual curve (Fig. 1 and 2) and a cumulative curve (Fig. 3 and 4). The annual curves are used when the annual income varies from year to year throughout the life of a project. The cumulative curves can be used to obtain one *lump* deferment factor if the income is constant year by year or assumed constant. The two sets of curves are broken into two parts — Part I — 0 to 5 years, and Part II — 5 to 50 years — to give greater weight to the early life of a project. A few simple numerical examples should clarify the use of these curves and make them a useful tool for all future valuation work. (For more precise interpolation in evaluation studies, copies of these curves drawn to larger scale and in greater detail are available directly from the author at Republic Natural Gas Company, Dallas, Texas.)

Example 1. Waterflood project — 10-year life, irregular cash income.

Determine present worth of these future earnings at 8% interest.

Year	Cash Income	8 Percent Discount Factor	From Figure*	Discounted Cash Income
1	$ 300,000	0.961	1	$ 288,300
2	400,000	0.890	1	356,000
3	500,000	0.820	1	410,000
4	600,000	0.757	1	454,200
5	600,000	0.703	1	421,800
6	500,000	0.652	2	326,000
7	400,000	0.604	2	241,600
8	300,000	0.556	2	166,800
9	200,000	0.511	2	102,200
10	100,000	0.475	2	47,500
Total	$3,900,000	0.693(Avg Dis Factor)		$2,814,400

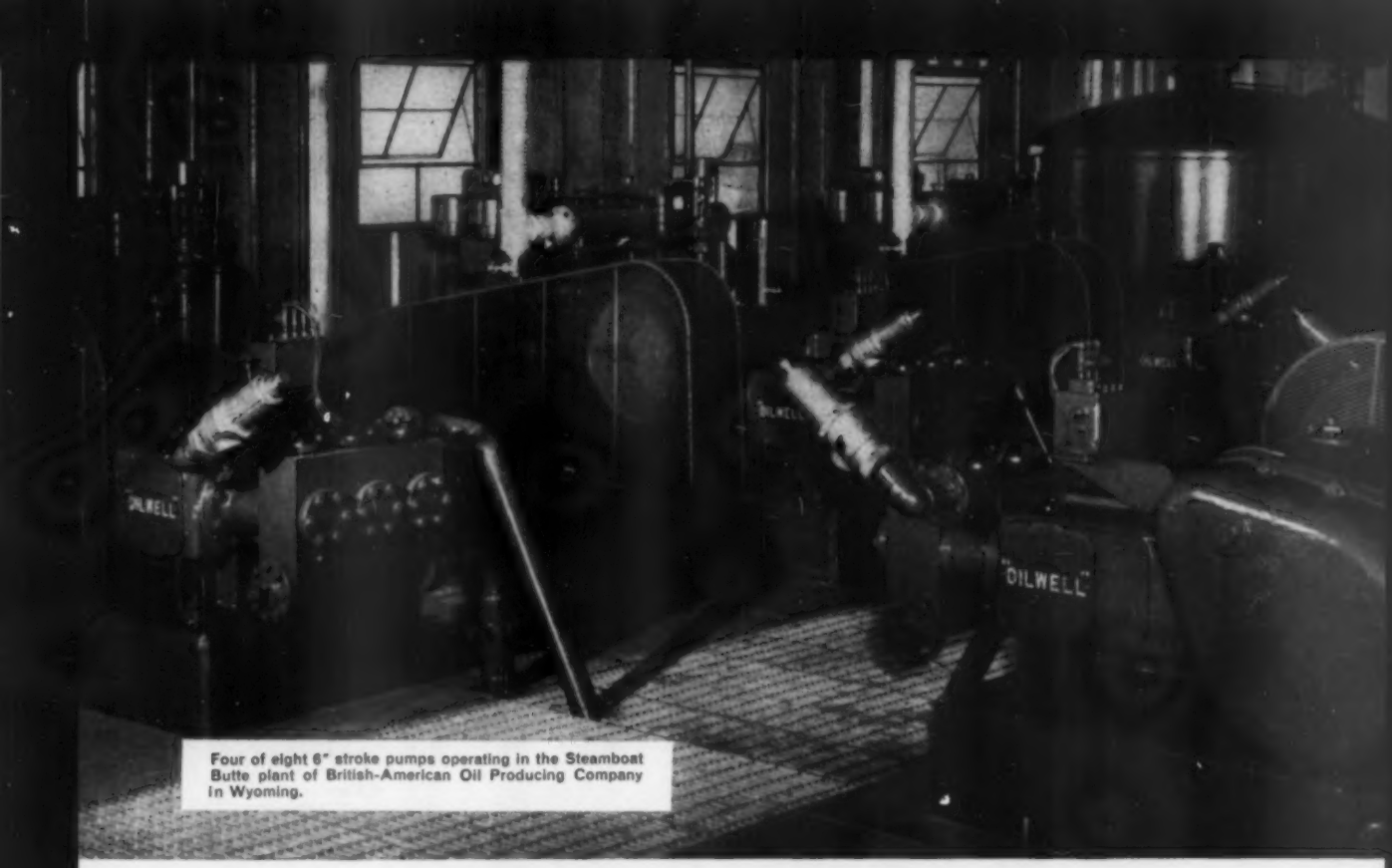
* Read values at year end.

Example 2. Gas sales at constant volume — constant price for 5 years.

Determine present worth of this gas income at 6% interest.
10 billion cu ft/yr at 10¢/Mcf = 1,000,000/yr

Solution A

Year	Cash Income	6 Percent Discount Factor	From Figure	Discounted Cash Income
1	$1,000,000	0.970	1	$ 970,000
2	1,000,000	0.915	1	915,000
3	1,000,000	0.860	1	860,000
4	1,000,000	0.809	1	809,000
5	1,000,000	0.762	1	762,000
Total	$5,000,000	0.863(Avg Dis Factor)		$4,316,000



Four of eight 6" stroke pumps operating in the Steamboat Butte plant of British-American Oil Producing Company in Wyoming.

Here's recorded performance of 8 "Oilwell" Water Injection Pumps . . . on the job 5 years!

THE British-American Oil Producing Company has eight "Oilwell" Triplex Plunger Pumps in its pressure-maintenance plant at Steamboat Butte, Wyoming. These pumps have been in operation for five years . . . and their cost-and-service record is outstanding.

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Excellent care and supervision in maintaining proper operating conditions have contributed to the economical functioning of the pumps.

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Average downtime per pump—
4.2 hours per year

Average parts cost per pump—
$86.14 per year

Here are the detailed facts:

Repair parts for five years	$ 3,445.50
Average repair parts per pump	$ 430.69
Average repair parts per pump per year	$ 86.14
Total downtime in five years	168 hours
Average downtime per pump	21 hours
Average downtime per pump per year	4.2 hours

Your "Oilwell" representative can give complete information on these or other plunger pumps which can give you similar service in waterflood applications. Be sure to contact him while your project is in the planning stage. His application experience will be helpful.

Exterior view of the Steamboat Butte plant.

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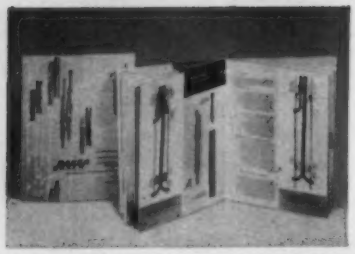

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Yours for the asking is Baker's Multiple Completion Guide, pictured above. It's a 24-page booklet of important engineering facts. In it are 13 of the latest and most practical hookups—dual zone, triple zone, quadruple zone. Write to Baker Oil Tools, Inc,. P.O. Box 2274, Terminal Annex, Los Angeles 54, California.

*9 Modern Production Packers

Single-Zone? Multiple-Zone? Water-Flooding? Deep Wells? Shallow? High Temperatures? Formidable Pressures? ■ The nine packers pictured here handle an impressive array of tough and simple production jobs.

These are

Packer Accessories? Baker offers a complete line that makes the packers more usable and adaptable. Dual and triple string flow tubes, for instance, and plugs and other accessories.

BAKER MODEL "D" RETAINER PRODUCTION PACKER

Product No. 415-D

The most widely used drillable packer in the world. Contains continuous sealing bore and flapper-type back-pressure valve.

BAKER MODEL "DA" RETAINER PRODUCTION PACKER

Product No. 415-DA

Direct variation of Model "D" with a larger I.D. sealing bore located in the upper end of the packer. Permits larger bore through pac. er accessories. Used as an upper packer in two-packer flowing or pumping, parallel string hookups.

* If you count the pictures, you come to number 9. But that's certainly not the total of packers made by Baker. For instance, Models "J" & "K" Snap-Set Packers are also made in double-grip versions. Model "E" is also offered with integral one-shot unloader, or with unloader and hold-down. Moreover, thanks to Baker's continuing program of packer research and development, new packers that will supplement the packers pictured above are coming.

Drillable

BAKER MODEL "F" RETAINER PRODUCTION PACKER

Product No. 415-F

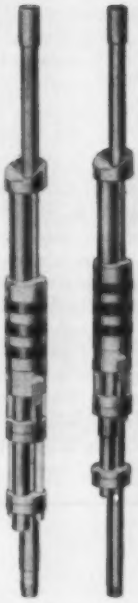
Related design to Model "D". Contains larger continuous bore than Model "D" Used where extra large bore is required in some parallel (triple) string, flowing or pumping hookups.

BAKER MODEL "FA" RETAINER PRODUCTION PACKER

Product No. 415-FA

Related to the Model "F" Packer in the same manner that the Model "DA" is to Model "D". Contains extra large upper sealing bore. Provides largest I.D. of any retainer-type packer. Used in multiple string hookups exclusively.

These are Retrievable



BAKER MODELS "J" AND "K" SNAP-SET DUAL PACKERS

Used as the upper retrievable packers in two or three-packer, parallel-string installations. Provides largest full-opening bores possible. For instance, 7" size has full opening for two 2⅜" tubing strings. Actuated by set-down weight only, and can be set and released as many times as required. Short string can be run and retrieved separately. Model "J" is long-string set; Model "K" is short-string set. Also available are Double-Grip versions that contain built-in, button-type, hydraulic hold-downs.

(left)
Model "J" Single-Grip Snap-Set Dual Packer
Product No. 756-J

(right)
Model "K" Single-Grip Snap-Set Dual Packer
Product No. 756-K

BAKER MODEL "M" SNAP-SET PACKERS

Product No. 635-M

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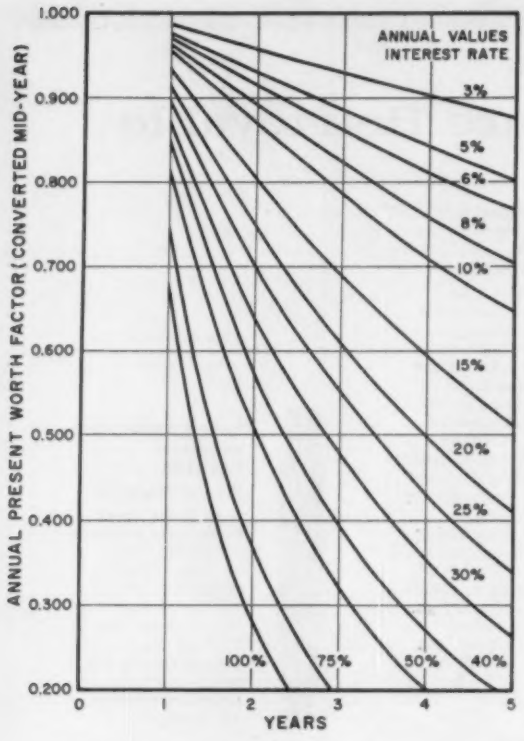

FIG. 1. **Present Worth of Future Earnings — Annual: 0 to 5 years.**
Interest converted semi-annually.

Solution B

Since this represents a constant income over a period of years the cumulative curves can be used to arrive at a solution with only one cumulative discount factor.

Fig. 3 gives a cumulative discount value of 0.865 which is very close to the figure obtained by calculating the individual yearly incomes. This would give a deferred income of:

$$(\$5{,}000{,}000)\,(0.865) = \$4{,}325{,}000$$

or 0.2 percent difference

Now that these four curves have been explained, the two basic considerations can be developed.

Given below is a summary of the recoverable reserves of sales gas condensate and plant liquid products to the producers account together with the capital expenditures necessary to fully evaluate these reserves.

The two basic contracts, interstate (20 year) and intrastate (10 year), are evaluated separately. Gross income, expenses and net income before income taxes are determined. Depreciation, depletion, and income tax at 52 percent are also included. Annual cash flow and total cash flow for the project life are also computed.

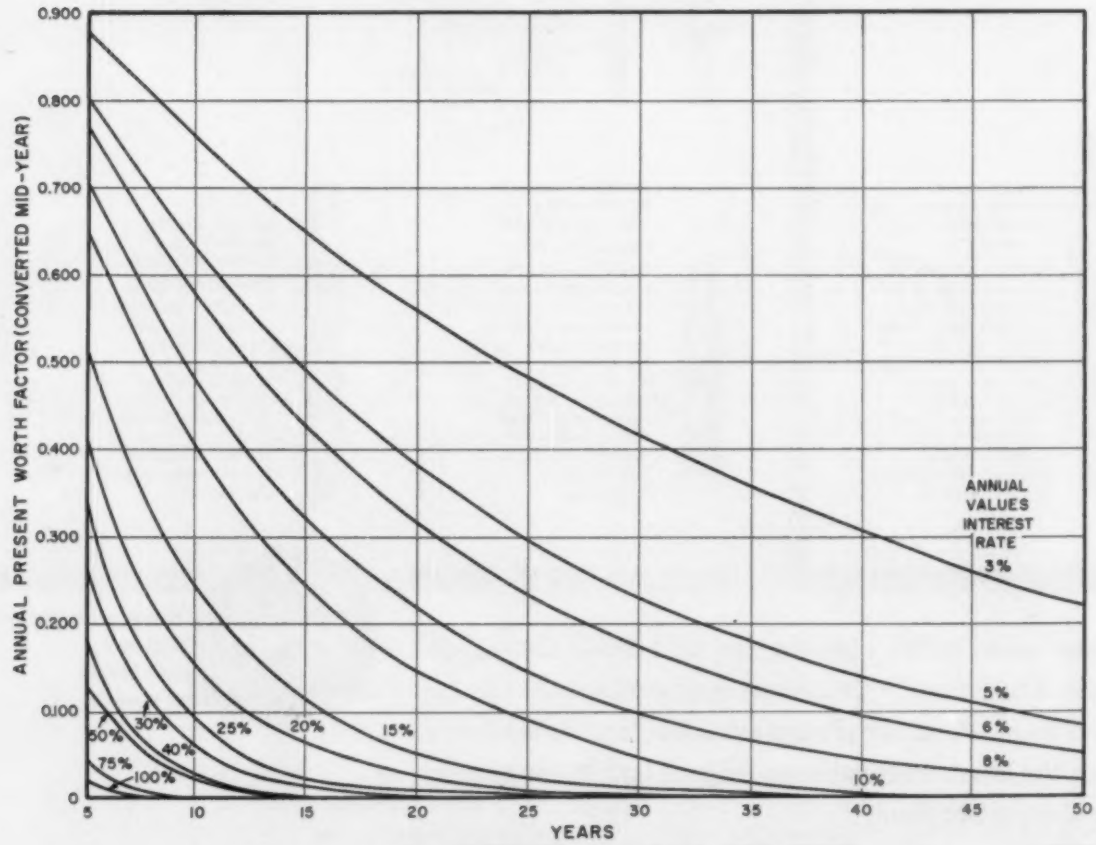

FIG. 2. **Present Worth of Future Earnings — Annual: 5 to 50 years.**
Interest converted semi-annually.

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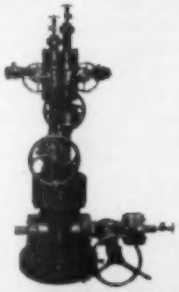

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ECONOMIC ANALYSIS
MULTIZONE GAS CONDENSATE RESERVOIR
for
Interstate and Intrastate Contracts

A. Total Recoverable Reserves
1. Sales gas— billion cu ft..... 440
2. Condensate—M gal..... 5700
3. Plant products—MM gal.... 395
to Producer 54.0%—MM gal. 213

B. Capital Expenditures to Develop Property

	Interstate	Intrastate
1. Geological and geophysical	$ 200,000	$ 200,000
2. Land and leasing	1,100,000	1,100,000
3. Drilling and formation evaluation	4,120,000	4,120,000
4. Gathering system and field processing	1,570,000	2,280,000
5. Estimated other capital costs	10,000	
Total capital expenditures	$7,000,000	$7,700,000

C. Contracts Involved

	Interstate		Intrastate
	15¢/Mcf	20¢/Mcf	10¢/Mcf
D. Life of Property or Contract—Years	20	20	10
E. Daily Volumes of Products Sold			
1. Sales gas—MMscf	60.25	60.25	120.50
2. Condensate—bbl	780	780	1,560
3. Producers share of plant products, gal	29,200	29,200	58,400
F. Liquid Prices—$3.25/bbl condensate 4.53¢/gal plant products			

G. Gross Income from Sales (Annual)

	Interstate		Intrastate
	15¢/Mcf	20¢/Mcf	10¢/Mcf
1. Sales gas	$3,300,000	$4,400,000	$4,400,000
2. Condensate	925,000	925,000	1,850,000
3. Plant products	482,000	482,000	964,000
Total	$4,707,000	$5,807,000	$7,214,000
Gross value/Mcf Incl Liquids, ¢/Mcf	21.4	26.4	16.4
$/Mcf	0.2140	0.2640	0.1640

H. Expenses per Mcf

1. Operating—$650,000/yr $/Mcf	0.0296	0.0296	0.0148
2. Royalty (16.67% gross) $/Mcf	0.0358	0.0442	0.0275
3. ORRI (2.0% gross) $/Mcf	0.0043	0.0053	0.0033
4. Production taxes (9% gross) $/Mcf	0.0194	0.0238	0.0148
5. Ad valorem $50,000/yr $/Mcf	0.0023	0.0023	0.0011
Total expenses	$0.0914	$0.1052	$0.0615

I. Net Value per Mcf (Gross value—Total expenses) $/Mcf	$0.1226	$0.1588	$0.1025
J. Annual Net Income (Sales volume/yr) (Net value per Mcf) BFIT	$2,720,000	$3,490,000	$4,510,000
K. Depreciation (straight line) $350,000 Interstate	$ 350,000	$ 350,000	$ 770,000
$770,000 Intrastate	—	—	—
L. Depletion (27.5% of gross income from production—plant products)	$1,160,000	$1,460,000	$1,750,000
M. Taxable Income (Net — depr — depl)	$1,210,000	$1,680,000	$1,990,000
N. Income Tax at 52% (This would probably be less due to intangibles)	$ 630,000	$ 875,000	$1,035,000

	Interstate		Intrastate
	15¢/Mcf	20¢/Mcf	10¢/Mcf
O. Total Cash Generated Per Year Net income (BFIT & D & D) — income taxes	$2,090,000	$2,615,000	$3,475,000
P. Total Cash Generated During life	41,800,000	52,300,000	34,750,000

To this particular point, Case I of operating the property or Case II of evaluating the property for purchase are essentially equivalent. From this point the property can be evaluated from the operator's or discoverer's standpoint by using set evaluation yardsticks.

Case I. Property Evaluation from Operator's or Discoverer's Standpoint.

	Interstate		Intrastate
	15¢/Mcf	20¢/Mcf	10¢/Mcf
1. Rate of return (accounting method) Annual net cash income + Capital invoice	29.9	37.4	42.6
2. Average annual profit (AAP), %	38.0	51.1	56.2

$$AAP = \frac{(r)}{(1 - ADF)} \frac{(Tot\ Def\ Inc - CI)}{(CI)}$$

r = interest rate = 5%
ADF = average deferment factor
TDI = total deferred income
CI = capital investment

3. Present worth profit, M$	$19,500	$26,200	$18,150
4. Ratio PW Profit/CI	2.78	3.75	2.36
5. Time of Payout—years (from PW Income)	3.67	2.88	2.50
6. Value of gas in ground—¢/Mcf (Present worth profit/reserves)	4.41	5.96	4.13
7. Rate of return by the discounted cash flow method, %	31.0	41.0	46.0

Case II. Property Evaluation from Proposed Purchaser's Standpoint.

This assumes the same conditions as in the basic problem. Here the possible purchaser must consider his own case. For example, the rate of return he is willing to accept, the deferred value he gives to the gas in the ground, how badly he needs it at its location, etc.

For example, if the possible purchaser will set up a schedule of probable rate of return, he can estimate the maximum he is willing to offer under any of these three conditions:

Rate of return by discounted cash flow method—%	(Proposed maximum purchase price) Interstate 15¢/Mcf MM$	Interstate 20¢/Mcf MM$	Intrastate 10¢/Mcf MM$
5	26.50	33.2	25.90
10	18.10	22.6	21.85
15	14.10	17.6	16.85
20	10.60	13.2	14.10
			(See Fig. 5.)

PURCHASE PROPOSAL

The proposed purchaser can determine his position for each of several purchase prices as outlined below.

II A. 15.0¢ Interstate Gas			
1. Assumed sales price of property, MM$.	14.0	16.0	18.0
2. Value of fixed assets to be depreciated, MM$	7.0	7.0	7.0
3. Assumed value of gas recoverable in ground to be depleted, MM$	7.0	9.0	11.0
4. Assumed value of gas in ground per Mcf, (440 billion) ¢/Mcf	1.59	2.04	2.50
5. Net operating income before D & D and income tax, MM$	54.4	54.4	54.4
6. Allowable depreciation, MM$	7.0	7.0	7.0
7. Allowable depletion, MM$	23.2	23.2	23.2
8. Taxable income, MM$	24.2	24.2	24.2
9. Income tax at 52%, MM$	12.6	12.6	12.6
10. Total cash generated, MM$	41.8	41.8	41.8
11. Payout time to return investment and pay income taxes during period, years	6.70	7.65	8.61
12. Remaining cash income after payout, MM$	27.8	25.8	23.8
13. P W total income at 5%, MM$	26.5	26.5	26.5
14. Average annual profit at 5%, money value, %	12.2	8.95	6.45
15. Return on investment— P W total income/investment	1.89	1.66	1.47

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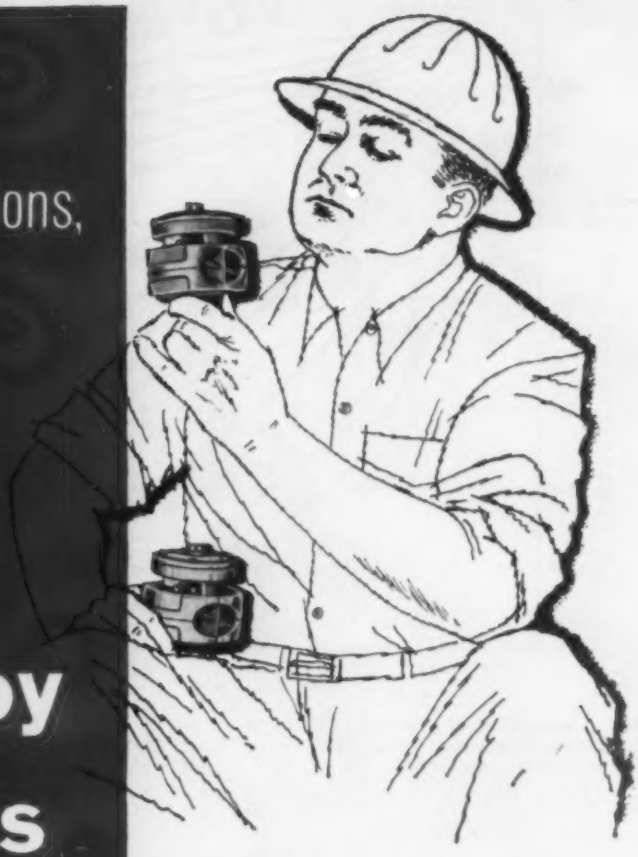

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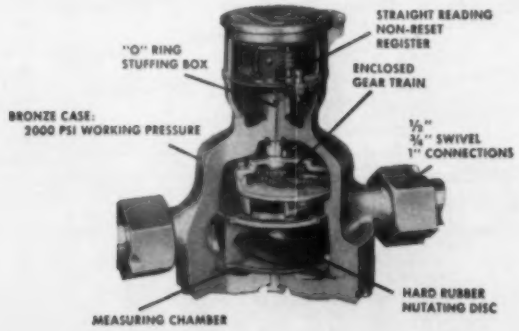
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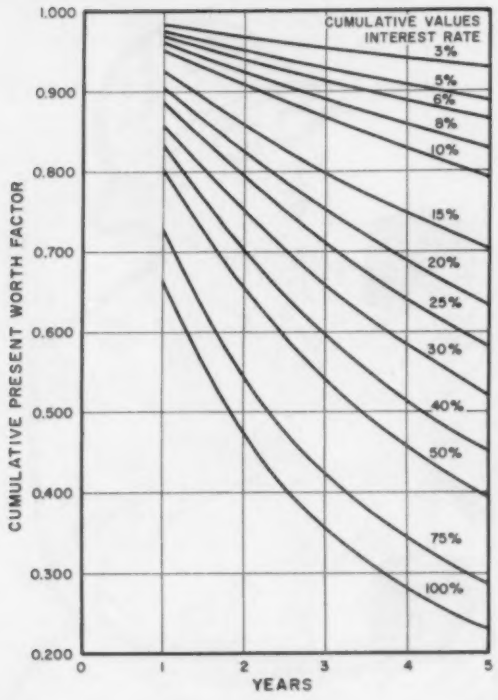

FIG. 3. **Present Worth of Future Earnings — Cumulative: 0 to 5 years.** Interest converted semi-annually.

The probable recommended price offer would not exceed 15.0 MM$ by the purchaser's appraiser and the owner's appraiser would recommend accepting not less than 16.0 MM$, a compromise of 15.5 MM$ could probably be reached.

How the financial matters would be handled in making the payments will not be considered herein. The consideration herein is strictly for cash, however, very possibly this would be a production type of payment as discussed in the previous installment on a bank loan.

If the other alternative were sold they would probably bring at *arms length bargaining* somewhere around 19.0 MM$ for the 20¢ interstate contract and around 18.5 MM$ for the 10¢ intrastate contract. (See Fig. 5.)

II B. 20¢ Interstate Gas			
1. Assumed sales price of property, MM$	17.0	19.0	21.0
2. Value of fixed assets to be depreciated, MM$	7.0	7.0	7.0
3. Assumed value of gas recoverable in ground to be depleted, MM$	10.0	12.0	14.0
4. Assumed value of gas in ground per Mcf, ¢/Mcf	2.27	2.73	3.18
5. Net operating income before D & D and income tax, MM$	69.8	69.8	69.8
6. Allowable depreciation, MM$	7.0	7.0	7.0
7. Allowable depletion, MM$	29.2	29.2	29.2
8. Taxable income, MM$	33.6	33.6	33.6
9. Income tax at 52%, MM$	17.5	17.5	17.5
10. Total cash generated, MM$	52.3	52.3	52.3
11. Payout time to return investment and pay income taxes during period, years	6.50	7.27	8.04
12. Remaining cash income after payout, MM$	35.2	33.3	31.3
13. P W total income at 5%, MM$	33.2	33.2	33.2
14. Average annual profit at 5%, money value, %	13.0	10.2	7.9
15. Return on investment— P W total income/investment	1.95	1.75	1.58

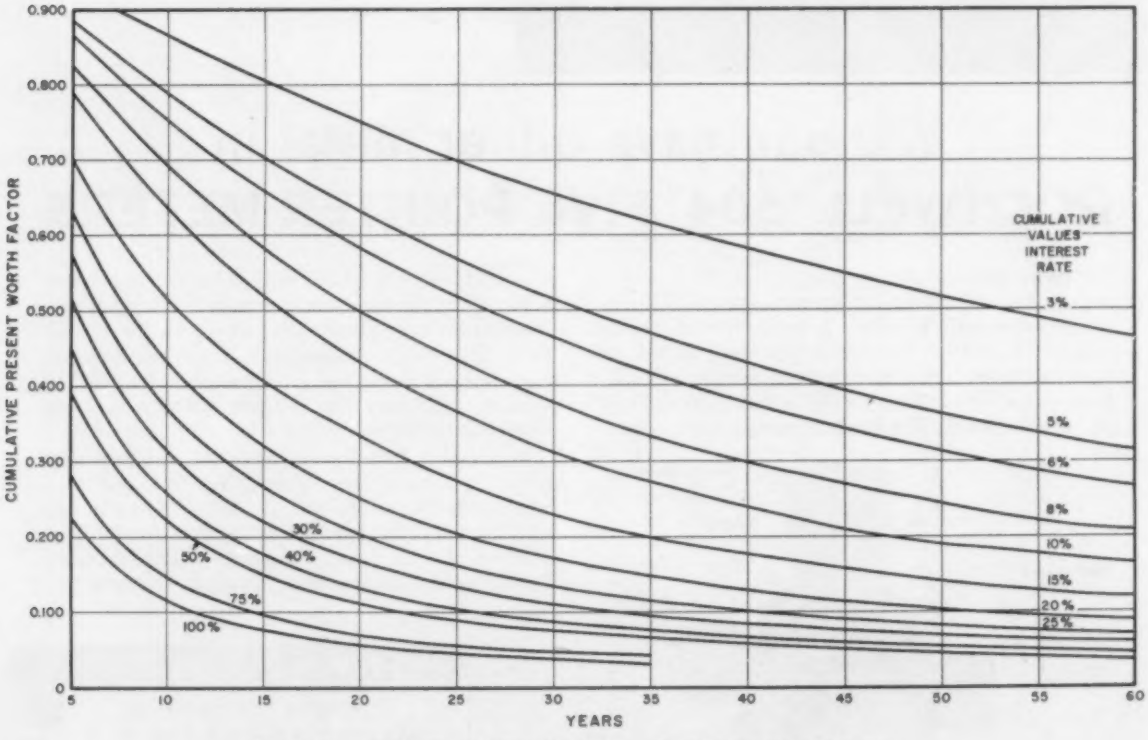

FIG. 4. **Present Worth of Future Earnings — Cumulative: 5 to 60 years.** Interest converted semi-annually.

NOTHING in Blowout Preventers

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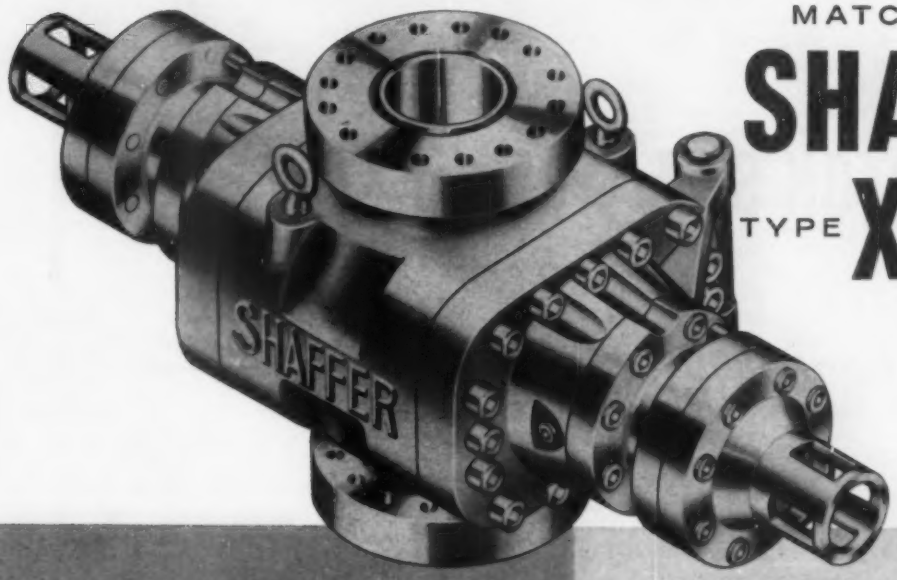
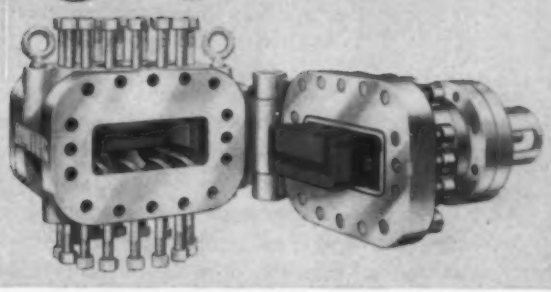


THERE'S FAR MORE to building a high pressure blowout preventer than just meeting a pressure rating. But if pressure rating is your first consideration, take a look at the kind of *extra high* pressures the Type XHP can handle . . .



- **7-1/16" Bore Size—22,500 PSI Test Pressure, 15,000 PSI Working Pressure!**
- **9" and 11" Bore Sizes—15,000 PSI Test Pressure, 10,000 PSI Working Pressure!**

But That's Only Part of the XHP Story. Although it has an extra high pressure rating, the Type XHP is not clumsy to service nor cluttered in its design.

TO CHANGE RAMS or service the ram compartment you simply unbolt and swing the end doors open. And there's the ram on one side for easy access—the open ram compartment on the other side for checking or service.

Best of all, you don't break hydraulic lines or lose hydraulic fluid each time you open the XHP. Hydraulic lines are built into the body—*and the hinge pins*—for leak-tight operation whether the door is open or closed.

AND, OF COURSE, the Type XHP has such other Shaffer advantages as QUICK-DRAINING RAM COMPARTMENTS, with the rams traveling on guide ribs high above any mud or sand that may collect in the compartment bottoms . . . and COMPLETELY ENCLOSED DESIGN with no exposed operating parts to become jammed or damaged by timbers or objects falling into the cellar.

COMPARE feature by feature and you'll find that nothing on the market equals the Type XHP for high pressure work combined with operating dependability and simple maintenance.

36 years OF OIL TOOL LEADERSHIP

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HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT · FISHING TOOLS THAT EXCEL

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CASPER, WYOMING, Shaffer Tool Works, Post Office Box 827
HOUMA, LOUISIANA, Shaffer Tool Works, Post Office Box 827
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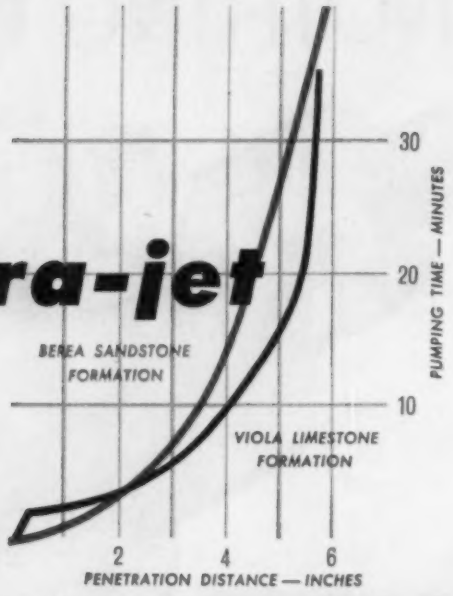
THIS FREE 12-PAGE BROCHURE gives you complete facts and figures on the Shaffer Type XHP. Write or phone your nearby Shaffer representative for your free copy!

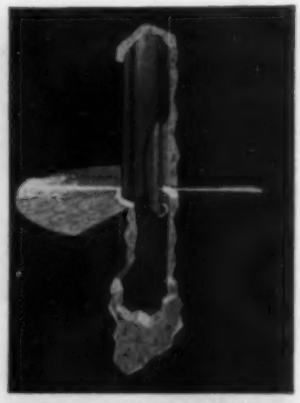
HALLIBURTON'S *hydra-jet*

position!
penetration!
profile!



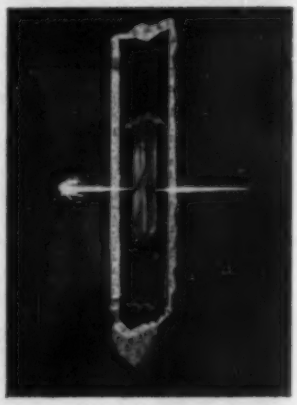
HYDRA-JET . . . for greater selectivity in formation fracturing . . . helps initiate a fracture at any desired depth . . . latest innovation in a long line of successful jetting tools dating back prior to 1940 when Halliburton introduced the Acid Jet Gun.

HYDRA-JET consists of a steel body with two or more positioned jetting nozzles and a back pressure valve. The jetting fluid, usually mixed with sand, is pumped into the tubing and jets out of the nozzles at high differential pressure. Tubing Manipulation guides the jet for cutting or perforating. The tool may be run and retrieved on the tubing or seated in the tubing and returned by wire line or reverse circulation.



HORIZONTAL FRACTURE INITIATION . . . By running the tool to the predetermined depth and slowly rotating the tubing while jetting, the jetting fluid will ring-cut the formation either through casing or open hole to help direct the subsequent fracturing operation in a horizontal plane.

VERTICAL FRACTURE INITIATION . . . Another version of the tool may be moved up and down with the tubing while jetting, causing vertical slots to be cut on either side of the hole. This tends to direct the fracturing operation in a vertical plane.



OTHER USES FOR HYDRA-JET: • Perforating • Formation Reaming Below Casing • Open Hole Under-reaming • Perforation Washing • Cutting Casing • Open Hole Washing – Look into the advantages of Halliburton Hydra-Jet. Contact us today!

HALLIBURTON
FRACTURING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

II C. 10¢ Intrastate Gas			
1. Assumed sales price of property, MM$.	16.0	18.0	20.0
2. Value of fixed assets to be depreciated, MM$	7.7	7.7	7.7
3. Assumed value of gas recoverable in ground to be depleted, MM$	8.3	10.3	12.3
4. Assumed value of gas in ground per Mcf, ¢/Mcf	1.89	2.34	2.79
5. Net operating income before D & D and income tax, MM$	45.2	45.2	45.2
6. Allowable depreciation, MM$	7.7	7.7	7.7
7. Allowable depletion, MM$	17.5	17.5	17.5
8. Taxable income, MM$	20.0	20.0	20.0
9. Income tax at 52%, MM$	10.4	10.4	10.4
10. Total cash generated, MM$	34.8	34.8	34.8
11. Payout time to return investment and pay income taxes during period, years	4.60	5.20	5.75
12. Remaining cash income after payout, MM$	18.8	16.7	14.8
13. P W total income at 5%, MM$	27.3	27.3	27.3
14. Average annual profit at 5% money value, %	16.8	12.3	8.7
15. Return on investment— P W total income/investment	1.70	1.51	1.36

Summary

For the 440 billion cu ft of purchased reserves, the discoverer and operator will make a capital expenditure of $7,000,000 and will make a 5-percent present-worth profit of $19,500,000 for the 15 cent gas contract and 5-percent present-worth profit of $26,200,000 for the 20 cent gas contract under interstate transmission. For the intrastate, the capital expenditure would have been $7,700,000 and would have resulted in a 5-percent present-worth profit of $18,100,000 on the 10 cent gas contract. This proved reserve would probably bring a purchase price of $15,500,000 from a prudent gas operator for the 15 cent interstate contract; $19,000,000 for the 20 cent interstate and $18,500,000 for the 10 cent intrastate contract. This would be equivalent to a rate of return on the purchaser's investment of 13.2 percent for the 15 cent interstate contract, 13.5 percent for the 20 cent interstate contract, and 12.7 percent for the 10 cent intrastate contract.

Conclusions

The solution to the problem given herein is only one of a number possible for this type of property evaluation. It is to be emphasized that this solution is at best only a guide or approach to a more fully developed study.

The actual evaluation of true value of a property of this type depends on the judgment of the appraiser and the persons or organizations for whom the evaluator or appraiser is making the study.

A study of this type within an operating company is obviously a teamwork effort.

True evaluation requires the expert and competent work of many different individuals and departments. The Exploration Department, the Land and Legal Departments, the Drilling Department, the Engineering Department, the Tax Department, the Natural Gas and Gasoline Department, the laboratory facilities — both routine and research, the Production Department, and the Valuation Department all have definite functions in the study.

The true aim of such an evaluation is to present as complete and concise a study of the properties as possible to serve as a competent guide for better decisions by management in regard to the operation or possible purchase of these properties.

Overall company management cannot be concerned with the detailed calculations involved in an engineering appraisal or valuations of this type. They can only be concerned with the conclusions in the report and how the conclusions will guide them regarding uses of company funds and other matters. Management needs economic evaluations that are prepared with a high degree of integrity on the part of the engineers and others preparing the studies.

Data presented to management must be complete. The valuation should and must contain all the pertinent data

(Continued)

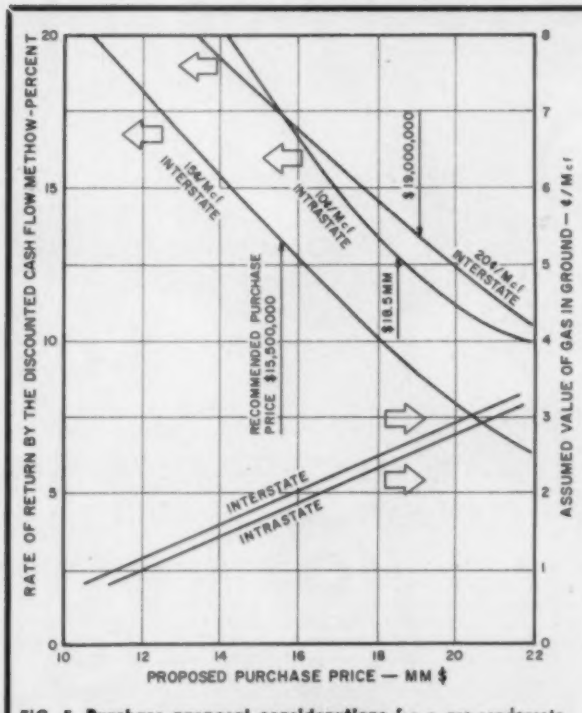


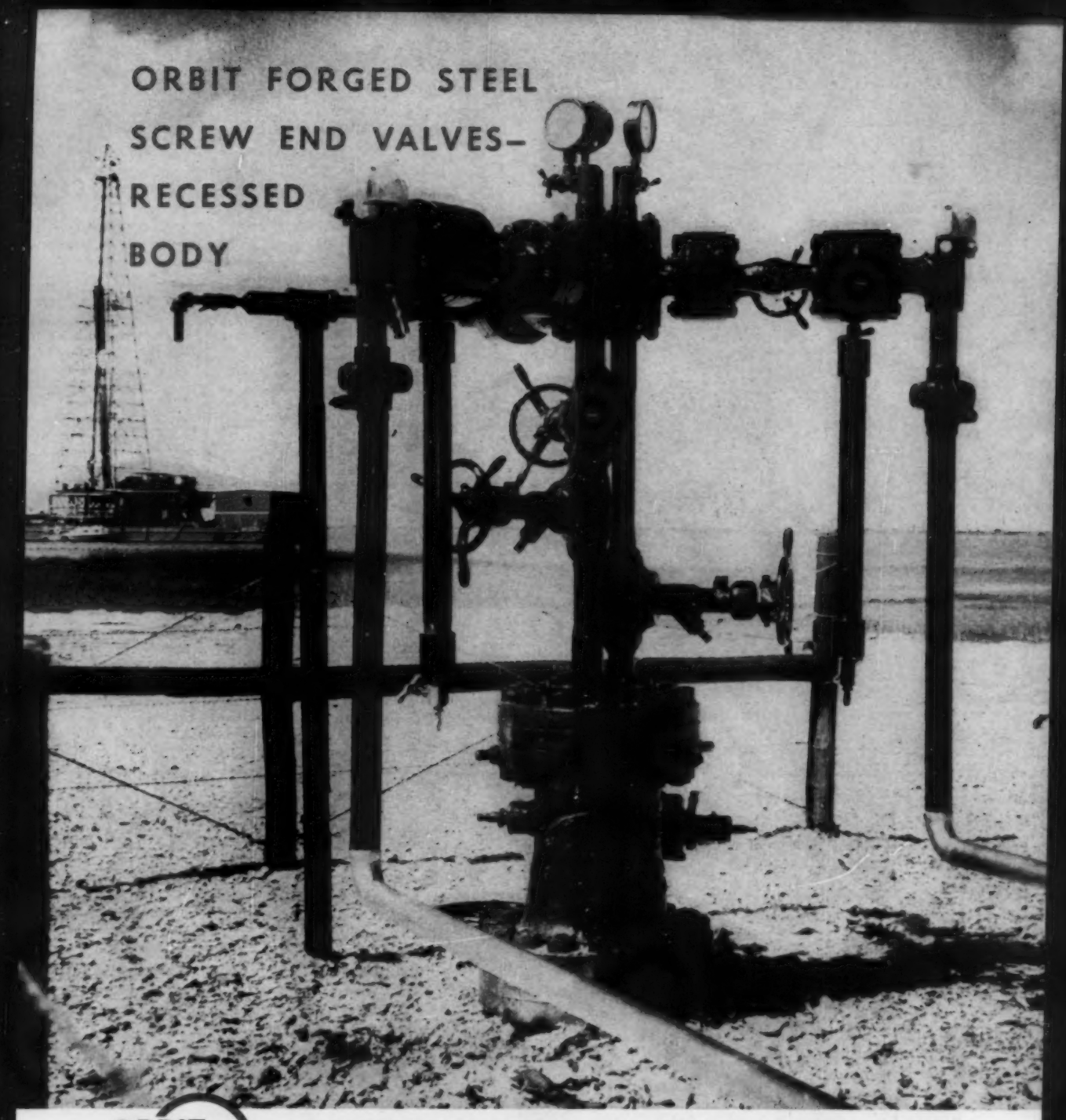
FIG. 5. **Purchase proposal considerations** for a gas-condensate property.

Economic analysis of purchase price as a function of rate of return by the discounted cash flow method and in-place value of gas with accompanying liquids.

BASIC FIELD CONDITIONS

1. RESERVES (Recoverable)
   - Sales Gas, cu ft ..... 440 Billion
   - Condensate, bbl ..... 5700 Thousand
   - Plant Products, gal (to producer) ..... 213 Million
2. LIFE OF PROPERTY
   - Interstate .....20 Years
   - Intrastate .....10 Years
3. CAPITAL INVESTMENT
   - To Develop Property
   - Interstate ..... $7.0 Million
   - Intrastate ..... $7.7 Million
4. GROSS VALUE OF GAS
   - (a) 15¢ Interstate ..... 21.4¢/Mcf
   - (b) 20¢ Interstate ..... 26.4¢/Mcf
   - (c) 10¢ Intrastate ..... 16.4¢/Mcf
5. TOTAL CASH INCOME (20 Years) (After Taxes Before D & D)
   - (a) 15¢ Interstate .....$41.8 Million
   - (b) 20¢ Interstate .....$52.3 Million
   - (c) 10¢ Intrastate .....$34.75 Million
6. TOTAL CASH INCOME PER MCF OF GAS WITH ACCOMPANYING LIQUIDS

(After Taxes Before D & D)	UNDISCOUNTED	DISCOUNTED
(a) 15¢ Interstate	9.50¢/Mcf	4.41¢/Mcf
(b) 20¢ Interstate	11.88¢/Mcf	5.9¢/Mcf
(c) 10¢ Intrastate	7.90¢/Mcf	4.13¢/Mcf



ORBIT VALVES®

A PRACTICAL LOW COST AND EFFICIENT WAY TO CONTROL A TRIPLE COMPLETION . . . USING ORBIT VALVES

The compact design and full round opening feature of Orbit Forged Steel Production Valves makes the screw end type readily adaptable to dual, triple, and quadruple string surface control. By using ORBIT SCREW END VALVES with the recessed body to permit perfect tubing alignment, a tremendous savings can be realized over other types of valves for multiple completions. Orbit Forged Steel Valves are built for continuous heavy duty production service, they always operate easy and shut off when called upon to do so. A pliable plastic packing with a shredded base of "Teflon"*, that is easily extruded, is provided as a stem packing in all Orbit Forged Steel Valves. This packing can be adjusted if necessary while the valve is in service and under pressure.

Orbit Forged Steel Valves (recessed body) are available through your favorite wellhead manufacturer for your prefabricated christmas trees in sizes 1", 1½", 2" x 1¾", 2½", 3" and 4", up to 4000-lb test, 2000-lb WOG, and in sizes through 3" up to 6000-lb test, 3000-lb WOG.

Write for Catalog 58-B.

*Registered trade-mark for duPont's "FEP-Fluorocarbon Resin"

ORBIT VALVE COMPANY P. O. BOX 699 / TULSA, OKLAHOMA / PHONE LUther 4-4761 / TWX TU 925

A 4-POINT BUYER'S GUIDE TO BEST DRILLING STRING VALUES

#1 A Spang drilling string is the industry's only fully integrated string

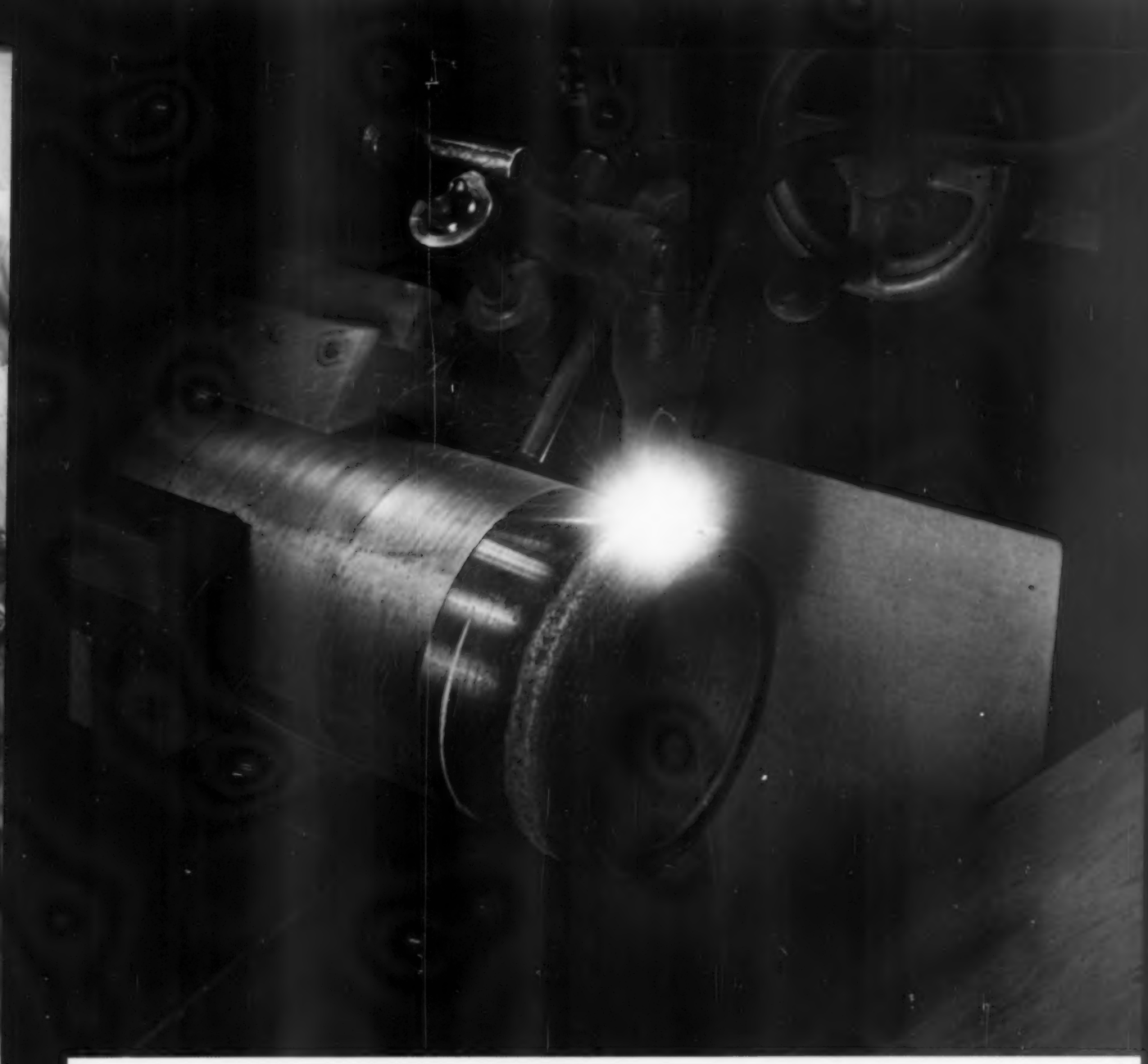
National Supply is the only company in the industry manufacturing both the drill pipe and the tool joints. From this *single* responsible source, you get a string that is quality controlled from start to finish.

NEXT . . .

#2 Spang leads in tool joint design—the critical area of pipe service life

SPANGWELD TOOL JOINTS are welded to the drill pipe by an automatically controlled operation insuring accurate alignment and a high quality weld. The welding permits a streamlined contour and a reduced number of threaded elements. This tool joint connection also allows the smallest practical O.D. and maximum bore—a definite advantage for slim hole drilling.

SPANG DOUBLE SEAL SHRINK THREAD TOOL JOINTS can be easily removed and replaced in the field. The joint design of SPANG Double Seal has an outer seal, threads and inner seal all on a single cone. This insures uniform, reliable installations both at the mill and in the field, and completely seals against internal and external pressures.

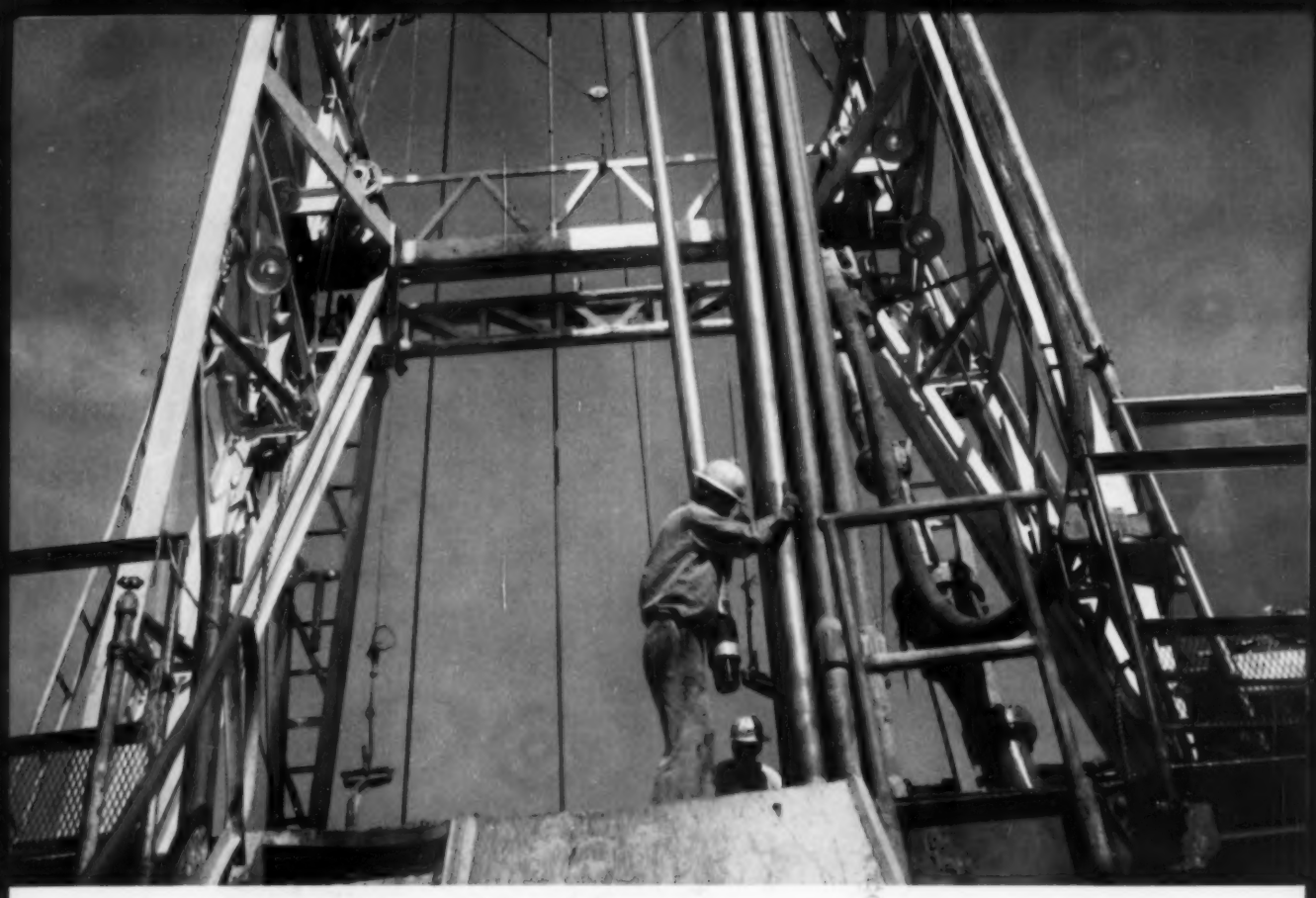


#3 Spang offers the best selective protection against abrasion and corrosion

SPANG HARDFACING (above) is a superior protection for tool joints in abrasive formations. It consists of multiple bands of tungsten carbide, *continuously* overlapped on the joint to form a solid particle-to-metal band. Method of application is the tungsten inert gas welding process.

SPANG PLASTIC COATING—the result of ten years of research—gives the best protection against corrosion. Scientifically applied at the mill on specially developed facilities, SPANG Plastic Coating is available not only in SPANG Drill Pipe but also SPANG Casing, Tubing and Line Pipe.

and finally...



#4 Spang consistently sets the performance standards by which all other tubular products are judged

Operators know that the established quality of SPANG Drill Pipe pays off in the well. That's why SPANG is almost always specified for the deepest wells . . . the big, important jobs.

Conclusion:

You get the best when you buy SPANG!

THE NATIONAL SUPPLY COMPANY

Two Gateway Center, Pittsburgh 22, Pennsylvania

Subsidiary of Armco Steel Corporation

DIVISION OFFICES; Calgary, Columbus, Dallas, Denver, Houston, Torrance, Tulsa
EXPORT: 600 Fifth Avenue, New York 20, N.Y., U.S.A.; City Wall House, Chiswell Street, London E.C. 1

Printed in U. S. A.

1.

THIS OTIS TOOL SAVED US

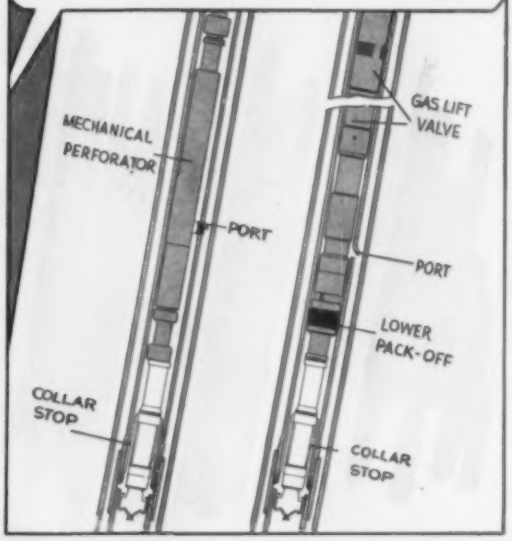
$350,000.00

IN WORKOVER COSTS LAST YEAR.

IT'S THEIR TYPE C GAS LIFT VALVE RUN WITH A TYPE G REMOVABLE TUBING PACK-OFF ANCHOR. WITH IT OTIS CONVERTED A NUMBER OF OUR OLD WELLS TO GAS LIFT WITHOUT PULLING THE TUBING — AND THEY WERE WELLS THAT WERE ORIGINALLY COMPLETED WITH NO PROVISIONS MADE FOR GAS LIFT.

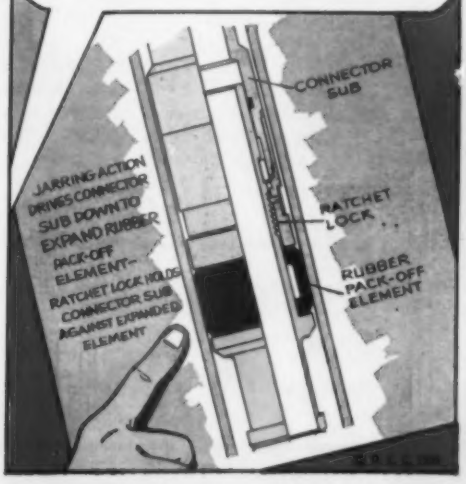
2.

The technique Otis uses in this type of recompletion is simple and fast. First, their gas lift specialists determine the number of valves required and the proper spacing. Then they cut a port in the tubing with a wire line mechanical perforator and pack-off their gas lift valve opposite the perforation. A full opening tubing stop locks the tool in the tubing. To give you some idea of the capacity of this type of installation, WE'RE MAKING 1,200 BARRELS OF FLUID PER DAY THROUGH 2" TUBING FROM ONE OF THESE WELLS.

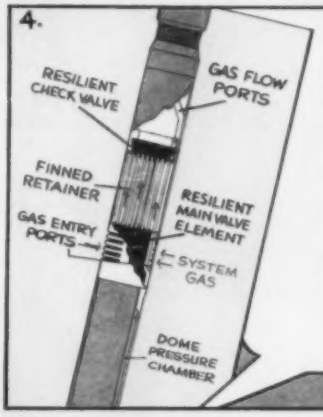


3.

And this Otis pack-off gas lift completion technique is one of the most foolproof we've ever had. For example, we know each valve straddles the port in the tubing because the lower pack-off anchor is landed on the same Otis collar stop used to locate the perforator. Also each check valve and pack-off can be tested as it's run by pressuring up on the tubing. And because the pack-off elements are set against the tubing wall mechanically, we know they'll stay expanded. Here's how the pack-off elements work.


CONNECTOR SUB
JARRING ACTION DRIVES CONNECTOR SUB DOWN TO EXPAND RUBBER PACK-OFF ELEMENT--
RATCHET LOCK HOLDS CONNECTOR SUB AGAINST EXPANDED ELEMENT
RATCHET LOCK
RUBBER PACK-OFF ELEMENT

4.



As for Otis Gas Lift Valves — this diagram will help explain why THEY REALLY LIFT THE FLUID. They have no spread — consequently you get maximum efficiency from your system gas. The valves have no moving metal parts, no bellows to fatigue, no seats to cut out — and they have extra flow ports to pass a maximum amount of gas at a minimum pressure. With Otis valves in your well you can produce by either continuous or intermittent lift — without the expense of changing valves.

Otis tells us they run a lot of these pack-off gas lift valves to straddle old style "piggy back" valves and eccentric side pocket mandrels when they become defective. They also install them in dual- and triple-completions. BEFORE YOU PULL TUBING to put any of your wells on artificial lift, I suggest you GET IN TOUCH WITH OTIS and talk to their gas lift specialists. We did, and it gave us some of the most economical and efficient gas lift installations we've ever had. It's no wonder Otis has the reputation of being

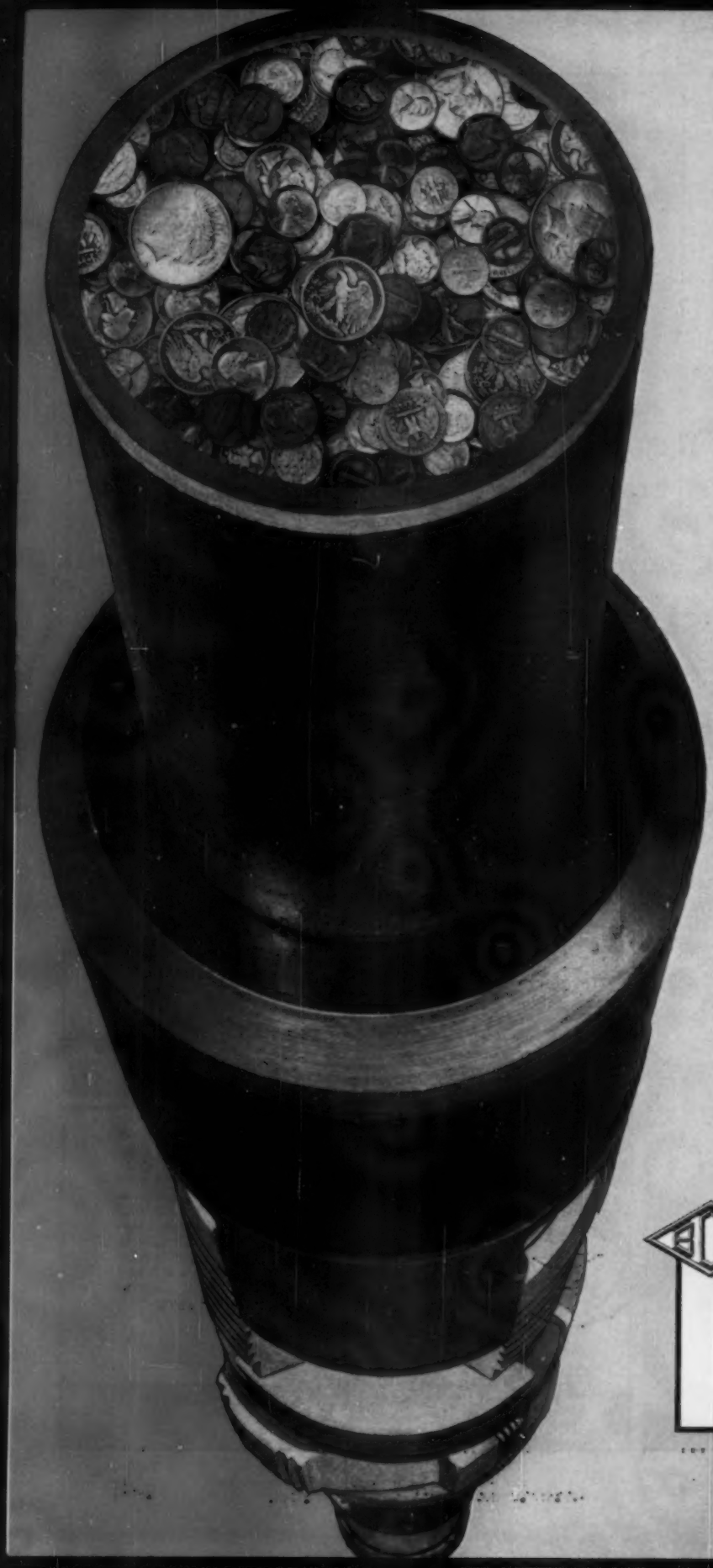
"First in Gas Lift Control"

OTIS

OTIS ENGINEERING CORPORATION

General Offices: 6812 Denton Drive • Dallas

Branches Throughout the Oil Country



BROWN CAM-LOK PROFIT PACKING PACKER

It's a fact the Brown Cam-Lok does more for your money – packs more profit when production totals are in.

Here's why:

Use Cam-Lok as a packer during the flowing life of your well. When the well goes on the pump, convert Cam-Lok to a tubing anchor while you are working over the well and run it back. Thrifty? You bet it is!

and positive, too . . .

Cam-Lok is the most controllable mechanical packer you can put in your well.

Less than one quarter turn of the tubing in either direction operates the unique Brown cam mechanism, to grip the casing like a pipe wrench working from the inside. This wrench grip, not friction springs or blocks, will lock the packer in place as long as torque is held in the tubing – to permit lifting or slack-off of the tubing to set or release the packer. Cam-Lok is the industry's best insurance against failure of a packer to release.

and it's simple to operate . . .

Cam-Lok is a tough, compact, full-opening, retrievable, reliable tool. In its simplest application, Cam-Lok is used as a weight set packer. Cam-Lok is set in tension to take advantage of pressure from below when testing, water flooding, fracturing, acidizing, or in shallow wells where the tubing weight and casing fluid column may not be sufficient to hold the packer weight-set against high bottom hole pressure.

Call the nearest Brown representative for full details and pack more profit in your next completion with the versatile, thrifty, positive Brown Cam-Lok Packer.

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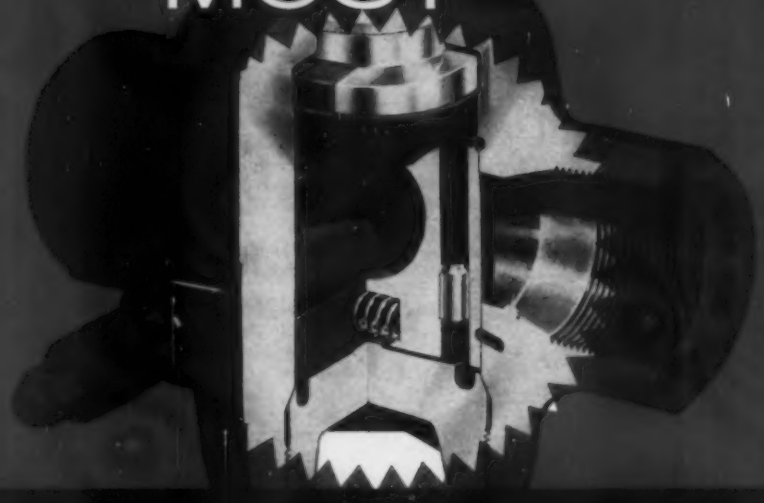
OIL TOOLS, INC.
8490 Katy Road Houston, Texas

GET THE MOST



THE MISSION VALVE THINKS FOR ITSELF TO SEAL AUTOMATICALLY

Not only is the Mission Valve always ready to seal, but the higher the pressure the tighter the seal. Line pressure forces Mission sealant through two semi-circular grooves around the downstream port, sealing like a plastic packing, to form a gas tight seal. Leaks are stopped *automatically* before they start. **The complete line** of 315 Mission Valves brings the positive advantages of easy opening and tight sealing to practically all valve applications. This wide selection, the Mission Guarantee, and the Mission Renewal Policy combine to make Mission Valves your best buy. Specify Mission and eliminate your valve problems.

MISSION
VALVE AND PUMP CO.

MISSION VALVE AND PUMP CO. *a subsidiary of* MISSION MANUFACTURING CO.
P. O. Box 4209, Houston, Texas cable address "MISSCO" • *export office: 30 Rockefeller Plaza, New York*

You save drilling dollars with

THE

MUD PROBLEM: Maintaining a stable lime mud at high temperature.

WELL DATA

Location: San Salvador Field, Hidalgo County, Texas
Total Depth: 16,684'
Bottom Hole Temperature: 356°F

MUD ADDITIVE PROGRAM

0' to	4000'	Native mud plus AQUAGEL*
4000' to	5800'	AQUAGEL, BAROFOS*, TANNEX* and caustic soda
	5800'	Converted to lime treated emulsion mud
5800' to	9000'	CARBONOX*, lime, TANNEX, Caustic soda, IMPERMEX*, diesel oil
9000' to	16,684'	CARBONOX (up to 20 lb/bbl of mud), caustic soda, lime, diesel oil; and MICATEX* and TUF-PLUG† in quantities from 10 to 30 lb/bbl of mud BAROID* was added as neccessary to control mud weight

TYPICAL MUD PROPERTIES

Depth	5850	7340	9229	12,057	14,918	16,684
Weight, ppg	10.2	12.2	15.5	17.3	18.0	19.1
Ave. sp gr, Solids	3.0	3.7	3.8	4.0	4.1	4.2
Viscosity, sec. API	43	44	54	63	78	58
Stormer Gel, 10 min	5	10	10	10	5	5
Filtrate, cc API	9.0	5.6	1.7	1.4	0.7	2.5
pH	11.8	11.5	12.0	12.5	12.5	12.4
Oil, %	10.0	10.0	12.0	11.0	10.0	9.0
Lime, excess ppb	1¼	1½	1	2	2½	1

CASING PROGRAM

Size Inches O.D.	*Depth Set Feet*
20	159
13⅜	2002
9⅝	8942
7	14921
5 (liner)	15960
3½ (liner)	16684

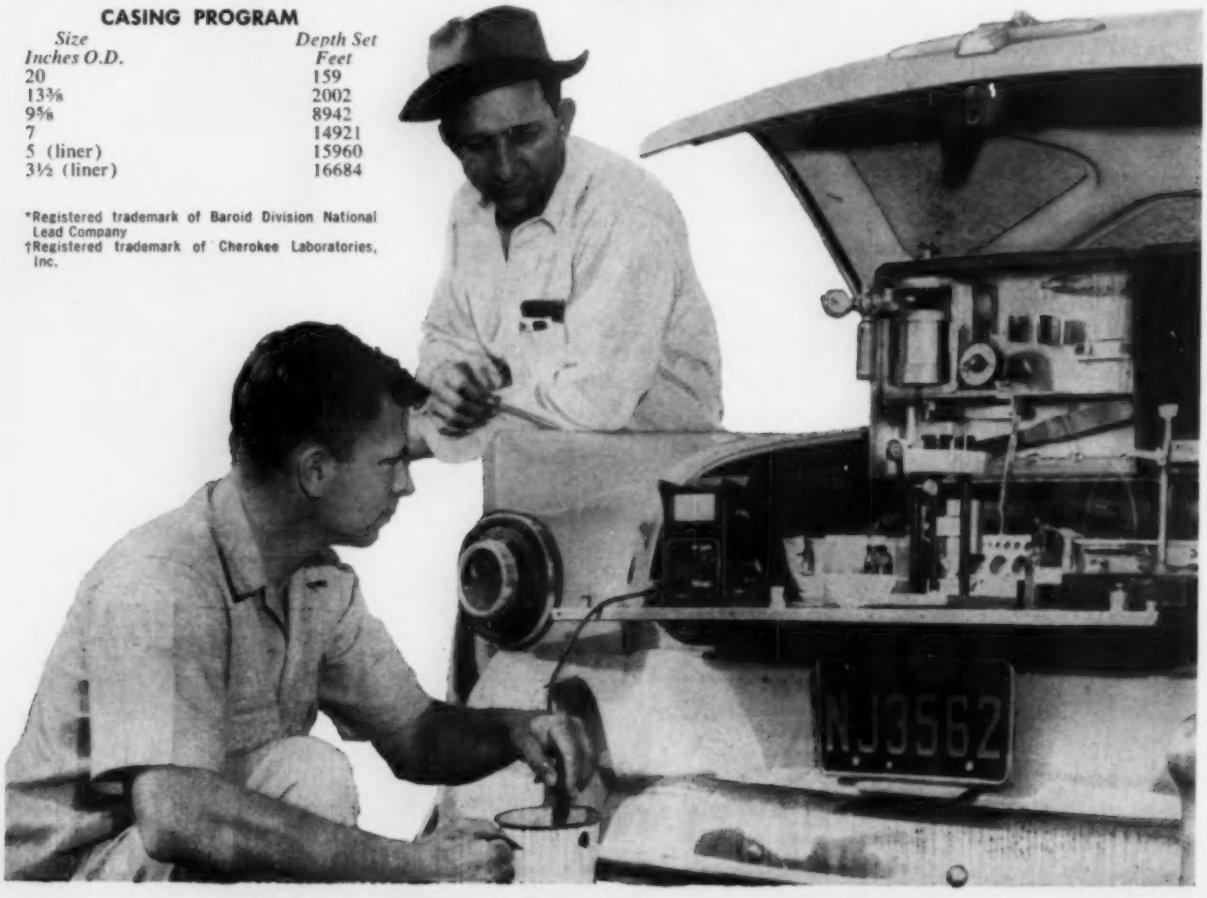
*Registered trademark of Baroid Division National Lead Company
†Registered trademark of Cherokee Laboratories, Inc.

PROBLEM: To maintain mud property stability at 356°F.

DISCUSSION: The problem of prevention of high temperature gelation, maintenance of desirable viscosity and filtration, and prevention of mud loss to formations became greater with increasing depth, mud weight and decreasing hole size. Additives used had to be compatible with all other materials in the mud and not adversely affect any other mud property.

SOLUTION: The best mud treatment was determined by conventional mud testing plus tests of treated samples aged at 25°F to 50°F above anticipated bottom hole temperatures. CARBONOX proved to be the best thinner for controlling high temperature gelation and viscosity and the most efficient additive for controlling filtration and filter cake thickness.

The Baroid Mud Centrifuge was used to separate and discard low specific gravity solids and reclaim 85 to 92% of the BAROID in the treated mud. The Mud Centrifuge helped achieve a reduction in mud maintenance cost of approximately 25%.



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

a Baroid Mud Program

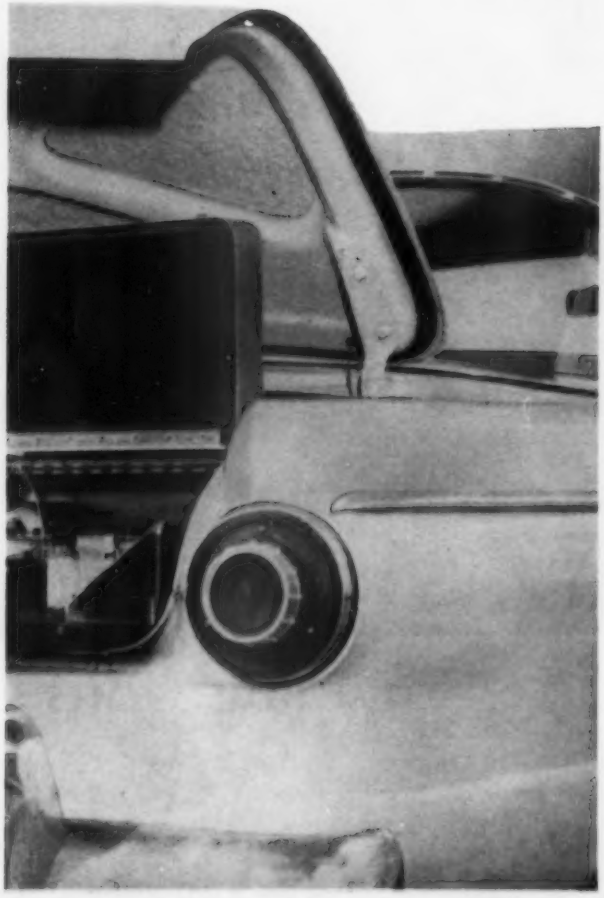
MUD PROBLEM

...and its solution

This case history shows how a complete Baroid mud program gives you successful mud control under the most adverse conditions. In this instance problems included depth to 16,684 feet, bottom hole temperatures up to 356°F, mud weight up to 19.1 lb/gal, salt contamination and lost circulation.

Baroid engineered services and products, coordinated with a pilot-tested program, enabled operating crews to maintain a lime-treated oil emulsion mud that was always as thin as needed . . . that did not gel excessively at high temperature . . . that had low filtrate loss . . . and that cut mud costs by 25%.

Baroid's improved new concept of modern marketing methods gives you an integrated mud service assuring quality control of products, engineering accuracy and technical ability that combine to save *your* drilling dollars.



MAINTAINS GOOD EMULSIONS
THINS MUD WITHOUT DILUTION
KEEPS MUD STABLE AT HIGH TEMPERATURE
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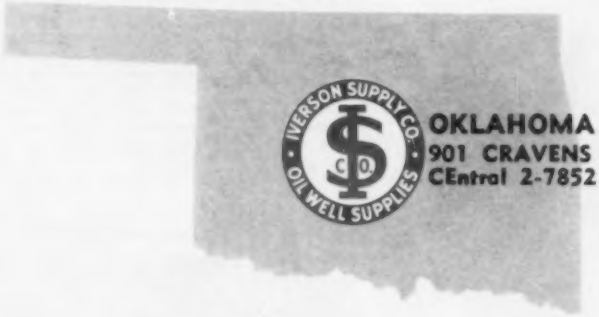

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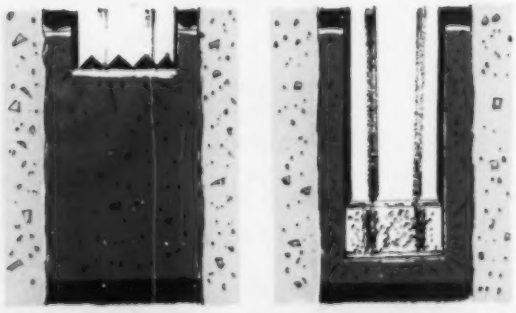

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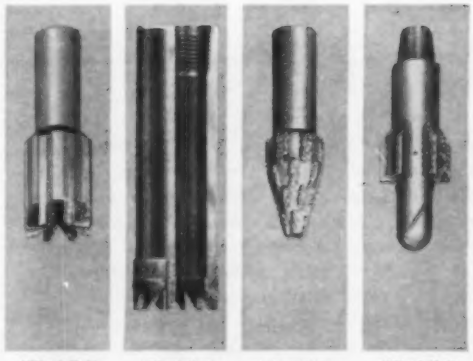

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without resort to safety factors and should incorporate the effect of income taxes. A company's profitability standards are subject to change due to changing economic conditions. With this in mind, a valuation report should be flexible enough to give management great latitude in final decision analysis.

Acknowledgments

It would be impossible for the author to acknowledge all the help and suggestions that have gone into the preparation of this series of articles. The accompanying bibliography and the reference list published in Part 4 represent only a portion of the articles that have been consulted during the preparation of the series. I do want to express particular gratitude to Mr. Jack R. Fraser and Mr. R. F. Madera for their continued help and encouragement and to Republic Natural Gas Company for permission to publish and present this material to THE PETROLEUM ENGINEER and to the School of Gas Technology.

If the readers derive as much benefit from the use of this material and from the references cited as the author did in the preparation of the articles, the author will feel that his efforts have been worthwhile.

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Problems and progress in . . .

Air and Gas Drilling in the Arkansas Valley Basin

Nearly one-half the total footage drilled in the Arkansas Valley Basin in the past few years has been with air or gas, making this area one of the most extensive testing grounds of the drilling method

William E. Toombs, *Technical Drilling Service, Inc., Oklahoma City, Oklahoma*

AS IN OTHER AREAS of the country, the adaptation of air and gas drilling in the Arkansas Valley Basin of west central Arkansas must be evaluated with relationship to drilling problems peculiar to this area. While the prime advantages of air and gas drilling in most areas are increased penetration rates and bit life, we can also expect better completions, straighter holes, and more accurate evaluations of productive zones.

In the past few years, approximately one-half the footage drilled in the Arkansas Valley Basin has been with air and gas as the circulating media. Table 1 outlines some of these wells with major drilling characteristics included. The majority of footage drilled has been in the Atoka formation. The lithology of the Atoka is primarily hard sandstones separated by black, caving shales with few fluid-bearing zones. Rotary mud drilling from surface to total depth has proved to be impractical in most cases due to slow penetration rates, crooked hole conditions which necessitate light bit weights, low footage rates per bit, some lost circulation conditions, and relatively expensive low-water-loss, high-viscosity drilling fluids. It has been proved by the proper application of rotary air and gas drilling methods that costs per well can be substantially reduced in this area.

Volume Requirements

Various and innumerable charts and tables have been prepared for determination of volume requirements in air and gas drilling. By using such constants as hole size, drill pipe size, depth, and penetration rate, a figure for circulation volume can be obtained. Drilling practices in the area in question establish that volume requirements to drill a hole conforming to standards will usually be less than stated by most published information. Annular velocities less than 3000 ft per min are recommended where no fluid intrusion is encountered. Instead of relying on constants as mentioned above, formation characteristics dictate the volume of air or gas to be circulated.

In hard sand formations, additional volume will not increase penetration rates. Moderate penetration rates and small cutting size require a minimum velocity in order to clean the hole. On some wells, as little as 1000 cu ft per min of air has been used to drill a 9-in. hole below 8000 ft in sand.

Also, a minimum velocity is recommended for drilling shale sections in order to reduce hole erosion. Even though faster penetration rates can be realized by additional volume, this should be sacrificed for keeping a gaged hole. Air or gas leaving the bit causes a turbulent flow before traveling up the hole. Excessive volumes cause a washing action on weak shale sections resulting in cavities. These cavities collect cuttings and cause fillup problems or even stuck drill pipe. Also, the cost of setting pipe is increased due to additional required cement.

In mist or foam drilling, volume requirements will increase 20 to 30 percent over requirements in dry drilling, depending on depth and fluid influx. Pressure requirements are usually in excess of 150 psi.

Due to the lower specific gravities of natural gas as compared to air, approximately 25 percent more gas volume is required to produce an equal lifting force. Operating pressures with gas drilling will be slightly higher than with air due to the additional volume required.

TABLE 1. Case Histories — Air and Gas Drilled Wells in the Arkansas Valley Basin.

Operator	County	Well Name	Circulating Fluid	Feet Drilled	No. of Days	No. of Bits	Maximum Circulating Volume—cfm
Gulf Oil Corp.	Sebastian	Beth Williams #1	Air	5358	33	24	1800
Shell Oil Company	Yell	T. V. Jones #1	Air	5776	20	12	1800
J. A. Chapman	Crawford	Chamberless #1	Air	4769	12	13	1425
Stevens Production Co.	Crawford	Gregory #1	Air	5215	16	26	1425
Gulf Oil Corp.	Logan	Roberts #1	Air	6847	37	29	1800
Stevens Production Co.	Franklin	J. L. Shinn #1	Air	4987	20	12	1200
Athletic Mining and Smelting Co.	Franklin	Mathews #1	Gas	1527	—	11	2100
Gulf Oil Corp.	Johnson	Wyss #1	Air	4308	30	28	1425
Gulf Oil Corp.	Pope	Bauman #1	Air (Mist)	3893	24	21	1800
Gulf Oil Corp.	Logan	ARECI B-1	Air (Mist)	5684	36	43	1800
Arkansas-Louisiana Gas Company	Franklin	Posey #1	Air	1910	—	6	1800

Handling Water Invasion

The problem of water entering the well bore from a water-bearing formation occurs because there is no head of mud in the annulus. Any water influx will wet bit cuttings and increase the load. Wet cuttings become sticky, forming rings or balls on collars, drill pipe, and sides of the hole. This causes a restriction of flow which compresses the air, further decreasing its lifting capacity. The final result is a loss of

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returns and possible stuck drill pipe if corrective action is not taken.

After formation water is encountered, two different approaches can be considered for the continuation of the air or gas drilling program. One approach is to provide a means to handle this water. This is accomplished by the injection of various chemicals into the hole along with the air or gas. The other approach is to shut the water off from the hole.

Water invasion of the hole can be divided into three classes:

1. Weeping zones (1 to 3 bbl per hr intrusion).
2. Quantities in excess of 3 bbl per hr which can be handled economically with air or gas.
3. Quantities which cannot be handled economically with air or gas.

Experiments by Pan American Petroleum Corporation* show that if the water present is between 10 and 35 percent of the weight of cuttings, the cuttings will become sticky and cause a balling action. This volume can be caused either from formation water or high humidity conditions which cause the compressors to inject condensing water into the hole. In general, it is found that the maximum intrusion rate for balling conditions is less than 2 bbl per hr.

Weeping zones can be handled by two different methods. The first method is injection of dry chemicals into the air or gas stream and the second method is use of water-soluble detergents. The two most widely used dry chemicals are calcium stearate and silica gel.

Calcium stearate. Calcium stearate is a water repellent which mixes with the cuttings and protects them against wetting by formation water.

Cuttings, when coated or mixed with the calcium stearate, become isolated from formation water and are blown out of the hole separately. Another application of calcium stearate is to reduce friction between the drill pipe and the wall of the hole.

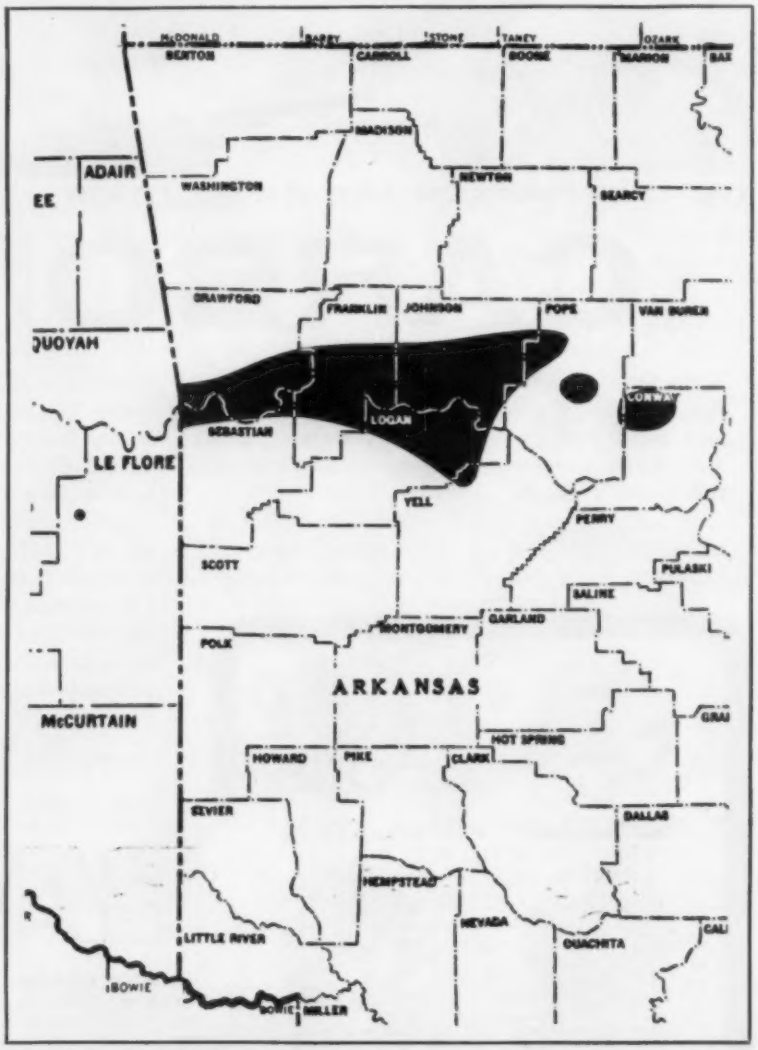
On one well in Logan County, Arkansas, injection of calcium stearate reduced drag on the bit from 35,000 to 23,000 lb. Circulating pressure was reduced from 220 to 170 psi. The main disadvantage in the use of this chemical is its high cost when used continuously. For example, in an 8¾-in. hole with 1 bbl per hr of water entry approximately 1.5 lb per ft drilled is required to handle this water invasion. Cost per pound is approximately $1. In addition, a dry chemical injector is needed for proper and even introduction into the air stream.

Silica gel. Silica gel is a water absorbant and is extremely valuable in drying up small amounts of water in wet holes. Injection of this drying agent can save several hours of rig time when used to assist in drying the hole after larger quantities of water have been blown out. Another use for this chemical is absorption of moisture produced by compressor equipment not equipped with aftercoolers and mist extractors. Cost of this chemical is approximately the same as calcium stearate.

For drying up small quantities of fluid, silica gel can be dumped down the drill pipe or can be injected through a lubricator with a two-valve arrangement. For drilling purposes, a dry chemical injector is desirable. Use of these dry chemicals for drilling purposes has been limited due to the exacting conditions necessary for satisfactory performance.

Foaming agents. For handling water invasion in excess of 3 bbl per hr, the most widely used method is injection of water soluble detergents and water. The process is most commonly known as mist or foam drilling. Principal advantages of mist or foam drilling are:

1. Surface tension in the hole is reduced, allowing air, fluid, and cuttings to be removed more effectively.
2. Fluid in the well bore is aerated more evenly and therefore can be blown out at reduced pressures.
3. Lubrication of the cuttings prevents balling action.



Area of air and gas drilled wells in the Arkansas Valley Basin is designated by the solid black area on this map of Arkansas.

*Randall, B. V., Lummus, J. L., and Vincent, R. P., "Stearates, Foaming Agents Combat Water in Air or Gas Drilling," *Oil and Gas Journal*, November 3, 1958, Vol. 56, Part 7, p. 79.

Like Convair's mighty Atlas missile,

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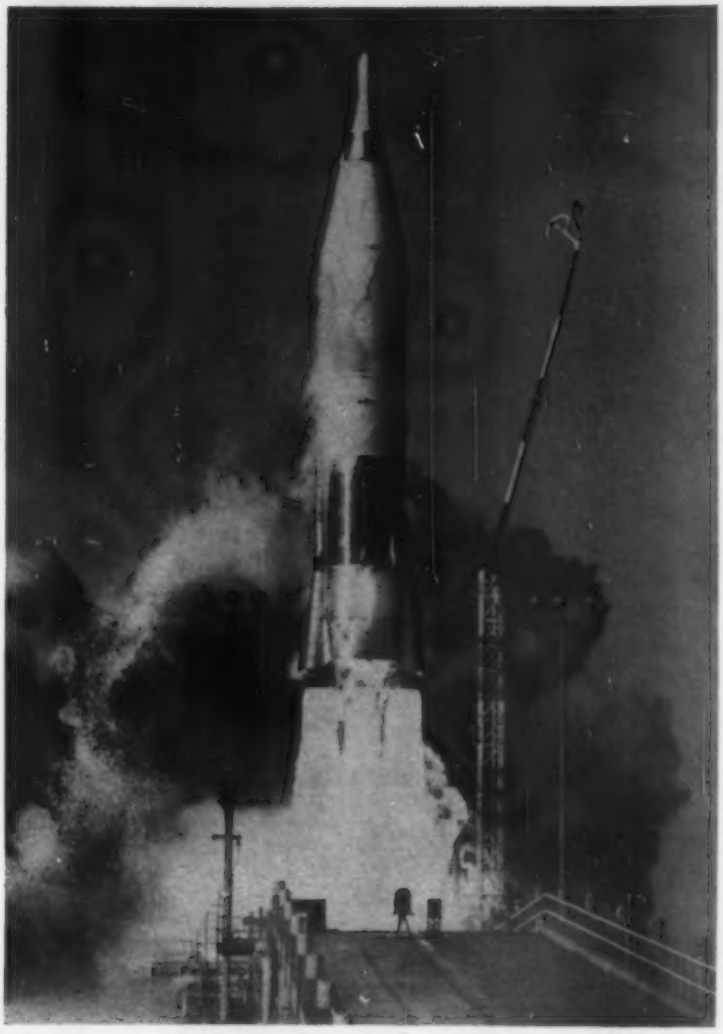
casing heads are "SEALED WITH STEEL"



The mighty Atlas missile is built to withstand all extremes of temperature change, from searing heat developed in the combustion chambers to extreme low temperatures encountered hundreds of miles from the earth in outer space.

The same welding principle that insures strength and safety in this giant of the rocket age, insures a perfect completion every time in Rector casing heads. Rector casing heads utilize a precision ground joint seat fitted with a welding ring which is welded directly to the casing. An API ring gasket completes the exclusive *ring of steel* pioneered by Rector.

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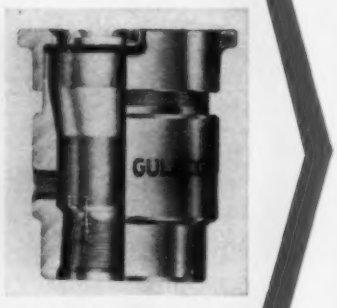
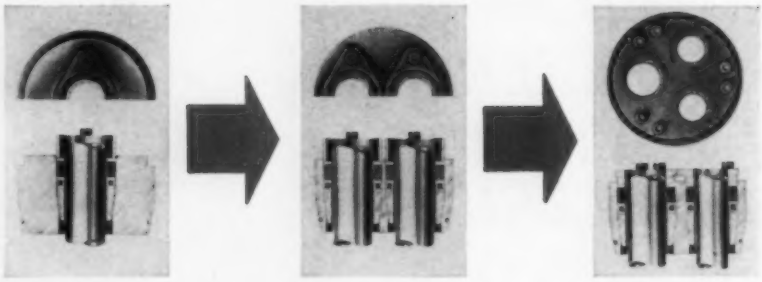


GULFCO'S CYC CASING HEAD



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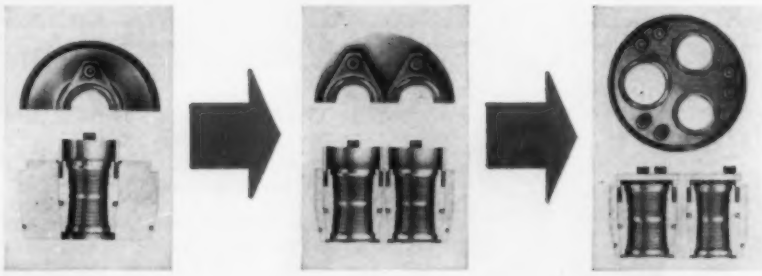
DUAL WITH SLIPS

TRIPLE WITH SLIPS



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These heads are all rated at 4,000-lb. test pressure. The body can be furnished with 7-5/8" or 8-5/8" male or female, or with Slip-On bottom for weld. The one standard body will accommodate the suspending and sealing elements for single, dual, or triple production strings as shown. All mandrels and slips will interchange in the standard bowl. All parts are interchangeable in the body. WRITE GULFCO TODAY, P. O. DRAWER 1150, BEAUMONT, TEXAS, FOR COMPLETE ENGINEERING DATA AND PRICES.

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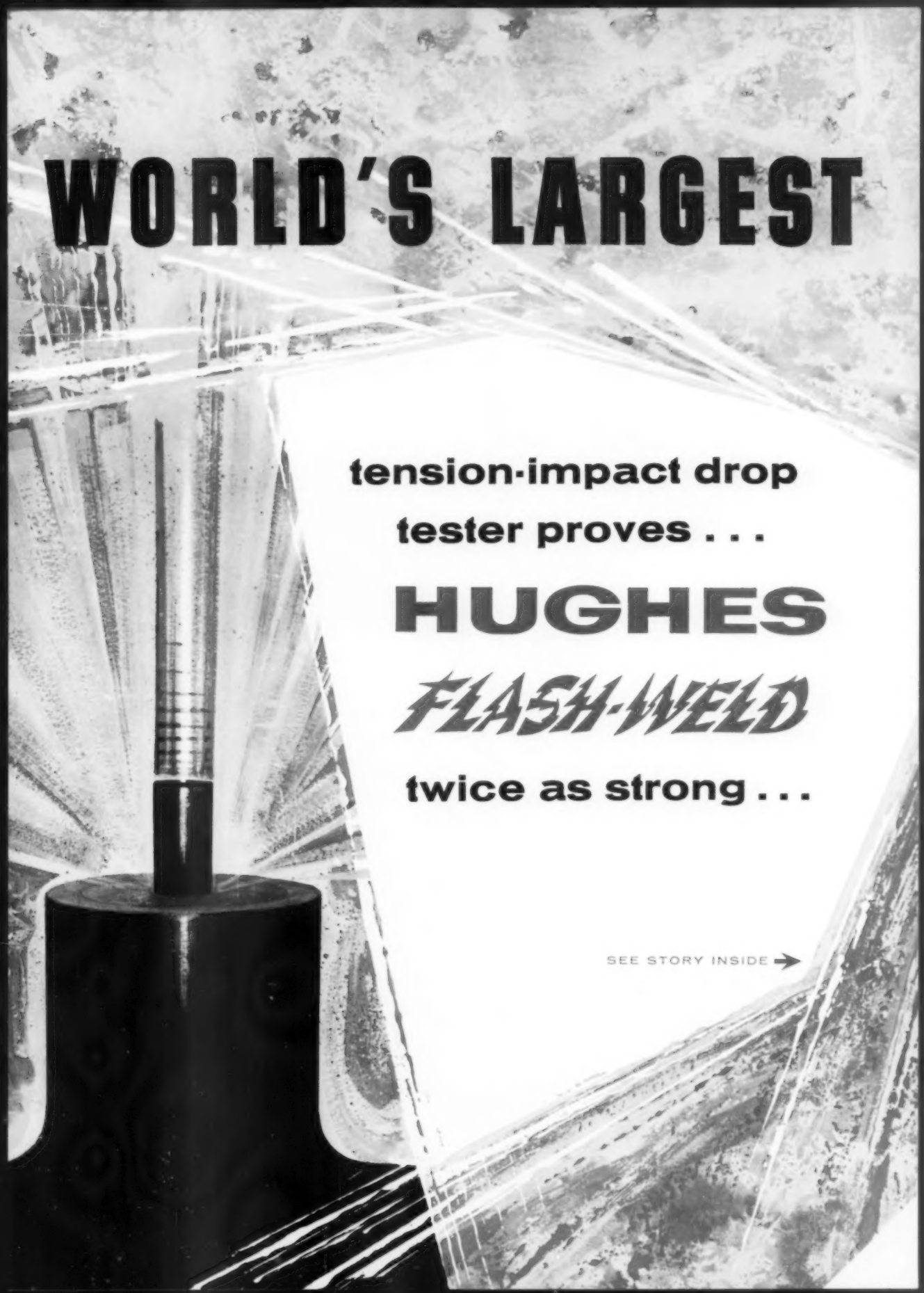
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tension-impact drop
tester proves . . .
HUGHES
FLASH-WELD
twice as strong . . .
SEE STORY INSIDE

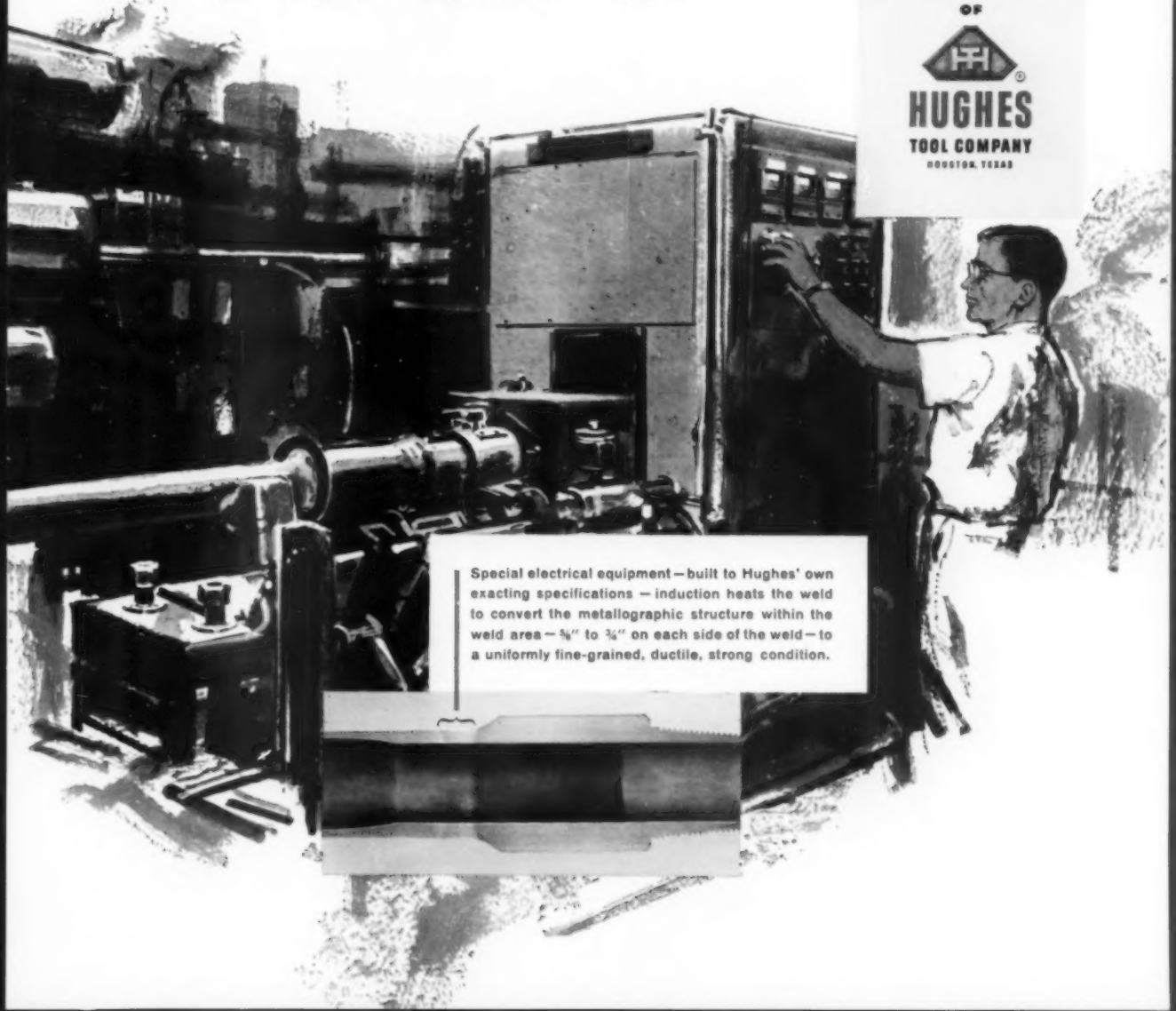
Magic Ring induction heat-treating more than doubles the impact strength of HUGHES "Flash-Weld" tool joint-to-pipe connections

Electronically-controlled inductor rings are used in the new Hughes heat-treating process to normalize and stress-relieve the weld area of "Flash-Weld" tool joint-to-pipe connections. This results in connections with metallographic uniformity across the weld never before available to the industry.

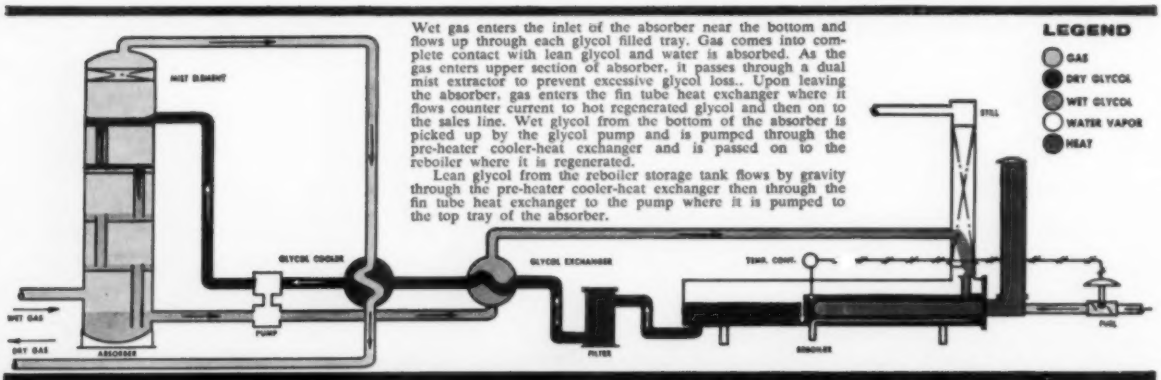
To fully evaluate the metallurgical properties obtained in the weld area by the new process, Hughes engineers developed the world's largest tension-impact testing equipment. A heavily weighted drillstem, dropped in a well and caught at the tool joint box shoulder in a steel anvil, subjects the welds to axial impact loads of more than 400,000 foot pounds. In more than 200 of these destruction drop tests—the severest to which welds have ever been subjected—not a single weld, heat-treated with the Hughes *Magic Ring*, was broken.

These important additions to the Hughes flash-welding process, plus other engineering and design features developed in unitizing more than 40 million feet of drill pipe since 1938, assure you the *most dependable* and *most economical* drillstem you can run in any well.

FLASH-WELD
A DEVELOPMENT
OF
HUGHES
TOOL COMPANY
HOUSTON, TEXAS



Special electrical equipment—built to Hughes' own exacting specifications—induction heats the weld to convert the metallographic structure within the weld area—⅜" to ¾" on each side of the weld—to a uniformly fine-grained, ductile, strong condition.

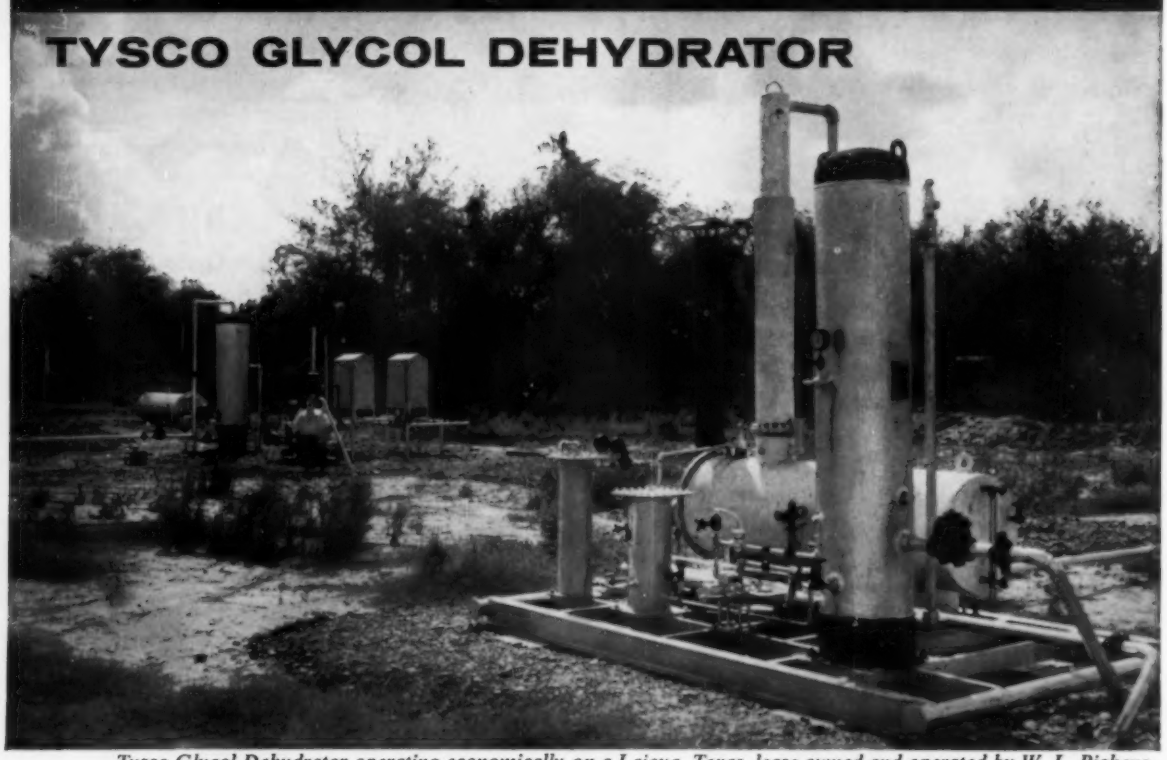


Wet gas enters the inlet of the absorber near the bottom and flows up through each glycol filled tray. Gas comes into complete contact with lean glycol and water is absorbed. As the gas enters upper section of absorber, it passes through a dual mist extractor to prevent excessive glycol loss.. Upon leaving the absorber, gas enters the fin tube heat exchanger where it flows counter current to hot regenerated glycol and then on to the sales line. Wet glycol from the bottom of the absorber is picked up by the glycol pump and is pumped through the pre-heater cooler-heat exchanger and is passed on to the reboiler where it is regenerated.

Lean glycol from the reboiler storage tank flows by gravity through the pre-heater cooler-heat exchanger then through the fin tube heat exchanger to the pump where it is pumped to the top tray of the absorber.

"... dries more gas with less glycol. With much less maintenance service."

TYSCO GLYCOL DEHYDRATOR



Tysco Glycol Dehydrator operating economically on a Lajoya, Texas, lease owned and operated by W. L. Pickens.

Tysco Glycol Dehydrators utilize an outside glycol to glycol pre-heater cooler to give maximum dew-point depression and the lowest possible operational cost. Pre-heater is mounted in series with a large gas to glycol fin tube heat exchanger. The main gas glycol fin tube heat exchanger is designed so that it gives a low glycol contact temperature. Gas is delivered with a water vapor content of never more than seven pounds per million standard cubic feet—*more often the water content is much less.* Glycol loss is less than one pint per million cubic feet of gas processed.

To find out how economical a Tysco Glycol Dehydration Unit is to own and operate, call your Tysco sales engineer, or write:

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4. The bit is kept cleaner for faster penetration and longer life.

Application of mist or foam drilling has proved successful on several wells in the Arkansas Valley Basin. The limiting factor in this area for this type of drilling is the amount and consolidation of shale sections above and below the water intrusion point. Volumes of 1 to 10 bbl of water have been handled economically on several wells. Penetration rates are reduced somewhat in mist drilling over straight air or gas drilling but compare very favorably over mud drilling in this area.

Another important factor in mist or foam drilling is the problem of corrosion of the drill string due to oxidation. Corrosion inhibitors should be injected along with the foaming agents to keep a pH of at least 10 on the return line. Drill pipe and collars should be inspected on every trip for pitting and scarring. Bit lubricants have increased the performance of bits in mist drilling.

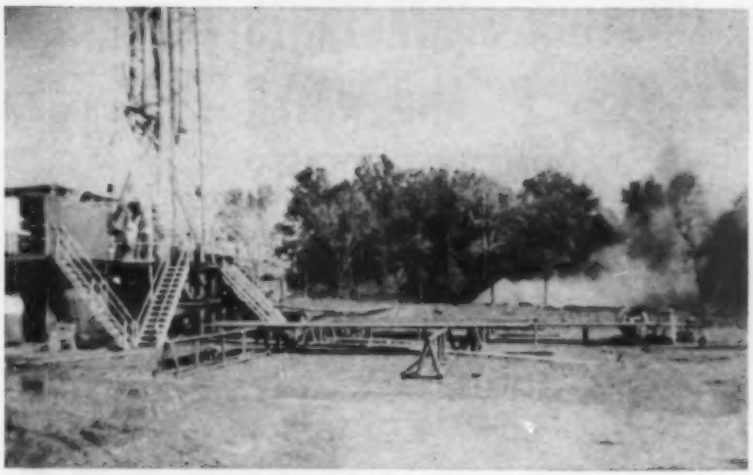
Other methods. Where quantities of water invasion are too great to be handled economically in the foremen-tioned methods or where hole conditions do not permit, several types of water shut-off mediums have been used for the continuation of air and gas drilling. The most widely used methods have been running an intermediate string of pipe with a Texas pattern shoe, and silicon tetrafluoride gas treatments.

Running an intermediate string of pipe with a Texas pattern shoe has been used mainly in areas where most water-bearing zones are known, especially on field wells. This method calls for the water bearing formation to be penetrated and the pipe run dry and landed without cementing. After completion of the hole, the pipe is retrieved. In some cases where water shut-off is not complete, 20 or 30 sacks of cement are used. One operator reports that out of 11 wells where this method has been used, only 110 ft of casing has been lost. Main disadvantages of this method are reduction in hole sizes required and possibilities of encountering deeper water-bearing zones.

The silicon tetrafluoride gas treatment at present shows much promise as an effective and economical means of shutting off water. This gas dissolves in all types of water with a chemical reaction which forms an insoluble precipitate. The primary precipitate is anhydrous silica gel. In salty formation water, other precipitates—fluosilicates—would be deposited.

The success of silicon tetrafluoride as a water shut-off material depends upon placement of the gas into the pores of the formation. This is accomplished by using a sweeping fluid, usually diesel oil, ahead of the gas. Air, natural gas, and nitrogen are used as flushing fluids. In cases of excess pressures, a pump-down plug is used after the flushing fluid and followed with water. The plugging action depends upon contact of the gas with water and the reaction is instantaneous, with no setting period required. Since the water-bearing zone must be isolated, a packer or packers are required. Production capacity of the formation determines the amount of gas to be used. These amounts usually vary from 2 to 10 lb of gas per ft of section.

Present costs for this type of treatment are approximately $1000 to $2000 depending on number of packers required and producing capacity of the formation. If proper arrangements are made prior to this treatment, only approximately 12 hours of rig time is needed to complete the process. The main disadvantage of this type of shut-off is its limited application in vugs and fractures. To date, three water shut-off treatments of this type have been executed in the Arkansas Valley Basin. Two of these treatments were successful.



Typical air drilling operation in the Arkansas Valley Basin. Blowing dust in the right background shows good return of cuttings from the well.

Percussion Drilling

The combination of the percussion type tool with standard air and gas drilling methods is the latest development for reducing drilling costs in the Arkansas Valley Basin. On one well in Faulkner County, penetration rates with the percussion type tool averaged 23.5 ft per hr as compared to 13.5 ft per hr with conventional air drilling, an increase of approximately 75 percent. Average bit life with the percussion tool was 200 ft per bit as compared to 130 ft per bit conventional, an increase of approximately 55 percent. Several more tests are scheduled in this area which will produce more information on the application of this tool.

Percussion tools are available in three sizes which will support bit sizes ranging from 6¼ to 12¼ in. The bits used are standard rock bits with heavier welds between legs and closer fitting bearing-retainer pins. Tests show that percussion tools operate more favorably in harder formations such as sands and siltstone than in softer shale formations.

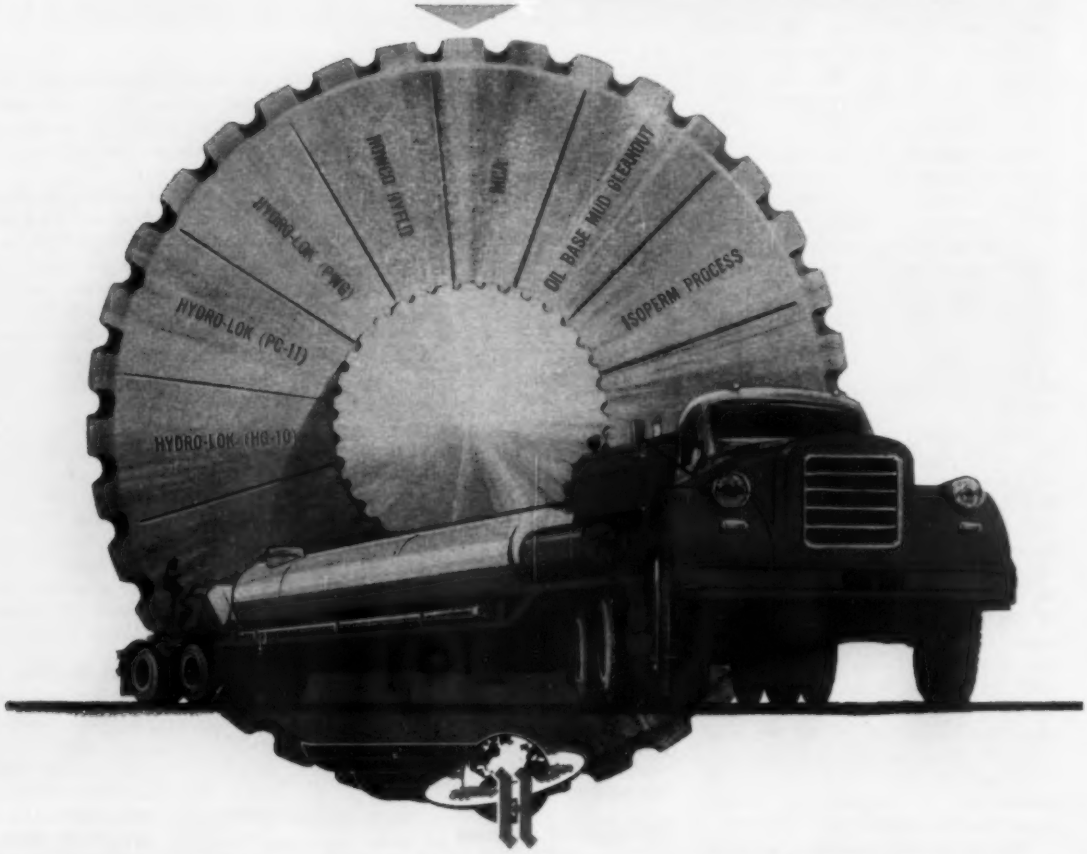
Volume requirements are approximately 15 to 25 percent greater than with conventional air or gas due to higher operating pressures and increased cutting loads. Operating pressures from 250 to 300 psi are required for maximum efficiency of the tool. A special float sub is needed in conjunction with the tool as standard floats will fail due to high frequency impact.

Future Air/Gas Drilling in The Arkansas Valley Basin

Well comparisons indicate that proper application of air and gas drilling methods will reduce drilling costs in the Arkansas Valley Basin. Increased knowledge and experience in handling water and water shut-off techniques have enhanced the possibilities of drilling a greater percentage of each hole with air and gas as the circulating media.

Any oil operator who has drilling plans in the area in question, should take advantage of the experience gained and knowledge available. The combined efforts by all companies represented in the Arkansas Valley Basin constitute the advanced drilling technologies which are being employed for further reduction of drilling costs.★ ★

HALLIBURTON SURFACTANTS AND WATER CONTROL AGENTS GIVE YOU SELECTIVITY



Production stimulation problems are as many and as varied as the formations that cause them. To help you overcome many of these problems with the greatest effectiveness, Halliburton has developed an extensive group of production stimulants. Each is designed to accomplish a certain task *best* in your well to aid you in obtaining maximum production from each formation.

Development of production stimulants, water control agents and the creation of new and improved chemicals for the petroleum industry is a tradition at Halliburton . . . a tradition which will continue to point the way to more efficient servicing of your well . . . and possibly more profit for you.

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SURFACTANTS

HOWCO HYFLO ●

A surfactant for use in oil designed to help break or prevent emulsions and water blocks. It is particularly effective in helping prevent emulsified obstructions in the formation flow channels resulting from oil base fracturing jobs.

Mud Cleanout Agent (MCA) ●

HCL plus Morflo II . . . a mixture designed to aid in restoring damaged permeability. It is particularly effective in shrinking and dispersing water sensitive clays . . . naturally occurring or deposited while drilling . . . also helps destroy water and emulsion blocks.

OIL-BASE MUD CLEANOUT ●

Since regular MCA is not effective on all oil-base and oil emulsion type mud cleanout problems, Halliburton has developed a surfactant-oil blend utilizing the excellent dispersing properties of DOC-3 . . . which can also be used on water base muds and for stuck drill pipe. A Howco Hyflo-oil mixture is also an oil base mud removal solution.

WATER CONTROL AGENTS

HYDRO-LOK (PWG) ●

PWG is a resin solution designed for helping shut off water bearing formations near the pay zone. Its extremely low viscosity aids in entering the true permeability of the formation before it sets. PWG setting time is very short, once setting begins. It forms a very stiff gel which will withstand considerable formation pressure, but is easy to drill out . . . also a proven pressure grouting chemical for helping control unwanted water in mining and construction operations.

HYDRO-LOK (PC-11) ●

PC-11 is a mixture of resins and inert solid materials which form a plastic slurry. It is very effective in controlling water in zones of high permeability, fractured sandstones and limestones. Also, the low viscosity of the resin in the slurry allows the treatment of low permeability formations.

HYDRO-LOK (HG-10) ●

This relatively low viscosity resin is recommended where deep penetration in the formation is necessary and a harder set than that obtained with PWG is desired. After setting, HG-10 is insoluble in all known solvents.

ISOPERM PROCESS ●

This chemical plugging agent is insoluble in most normal well fluids, but can be removed by a conventional acid treatment. The Isoperm Process is the injection of two chemical solutions that react in the formation. Their reaction forms a gelatinous presipitate which greatly reduces the formation's permeability, but does not plug it completely.

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Clay Mineralogy Problems In Oil Recovery: Part 2...

How to Combat Swelling Clays

...in drilling and subsequent producing operations depends upon a knowledge of the clay minerals related with the petroleum reservoir

John E. Moore, *University of Illinois, Urbana, Illinois*

CLAY MINERALS found associated with oil and gas sandstone reservoirs were either deposited intermixed with the sand grains at approximately the same time as the sand particles, or formed *in situ* by diagenetic or post-depositional alteration. Post-depositional or diagenetic modifications may form clay minerals by the alteration of a detrital component of the sand, such as feldspar, or may alter the deposited clay to some different type of clay mineral. The types of clay minerals found in these sediments are chiefly montmorillonite, illite and degraded illite, chlorite and degraded chlorite, mixed-lattice clays, and kaolinite.[10,15]

A generalized survey of the types of clays identified in oil-producing areas in the United States is as follows: Appalachian oil sands contain illite, kaolinite, and chlorite with illite as the dominant clay mineral[4,21]; Gulf Coast oil sands have high percentages of montmorillonite[6]; California oil sands contain montmorillonite (often the dominant clay mineral), illite, and kaolinite.[22,23]

There are very few oil-producing sands that are entirely free of clay minerals. This is the result of the fact that in normal sedimentation the sorting of particles is seldom perfect, which results in the dissemination of fine clay particles in the sand. The term "dirty sand" is used when the clay content is 5 to 15 percent or greater, and "clean sand" for approximately 1 to 5 percent clay content.[24] The clay content of Illinois oil sands ranges from 1 to 15 percent.[25] Johnston[24] points out that clean sands are more often found in the central plains and in the eastern areas of the country, while dirty sands are common in California.

Relation of Clay to Pore Space

Clay minerals occur in oil sands as a coating on the surface of sand grains and as discrete particles mixed with sand. These particles of clay are attached to the sand surfaces either at the time of deposition of the sand, or at a later time, due to alteration in place. Grim and Cuthbert[8], in investigations of the bonding action of different clays, noted from microscopic examination that it is very common to find clay plastered to the sand particles and they may be so tightly bonded to the sand that it is difficult to separate them. They found that sands bonded with montmorillonite had a smooth, regular coating, while kaolinite and illite bonded to sand in an irregular and uneven coating.

Because of this coating of quartz grains, the interconnected sandstone pore system is thus coated or lined with clay minerals. A sand with only 8 percent by weight of clay minerals in the 4 micron or less range would fill an appreciable volume of the pore space. If the clays were in expanded form, perhaps as much as 20 percent of the total volume of solid would be filled.[6,15] Johnston[24] points out that, due to the depositional history of detrital clay, in many parts of the sand body it is very likely that two adjacent sand grains may be separated by clay particles. Clay particles which are usually smaller than 4 microns are approximately within the size range of the pore sizes of sandstones (10 to 100 microns in diameter) and, when they are in an expanded state, could easily fill some of the pore channels.[6,26] Clay minerals are of the utmost importance in petroleum production because of their critical position in the pore space and because even minor percentages will influence the permeability of oil sand.

A sketch of the clay minerals in a reservoir pore space is shown in Fig. 8, illustrating two different conditions of the clay with reference to the quartz grains and the interstitial water. Fig. 8a illustrates the state of the clay in a stable condition (flocculated and unexpanded). The stable condition occurs when the clay minerals are in contact with the formation brine, which has a high saline content, a weakly alkaline pH, and flocculating cations. This state brings about unexpanded and flocculated clays which occupy a minimum volume of the pore space.

Fig. 8b shows the position of clay minerals in the unstable (deflocculated and expanded) condition. The unstable condition occurs because the character of the formation fluid has changed to one with smaller cation concentration, a slightly acidic pH, and deflocculating cations. The reaction of the clay minerals to these factors would cause base-exchange reactions, swelling, deflocculation, and an increase in the development of oriented water. These reactions would be most highly developed in reservoir sands containing the three-layer

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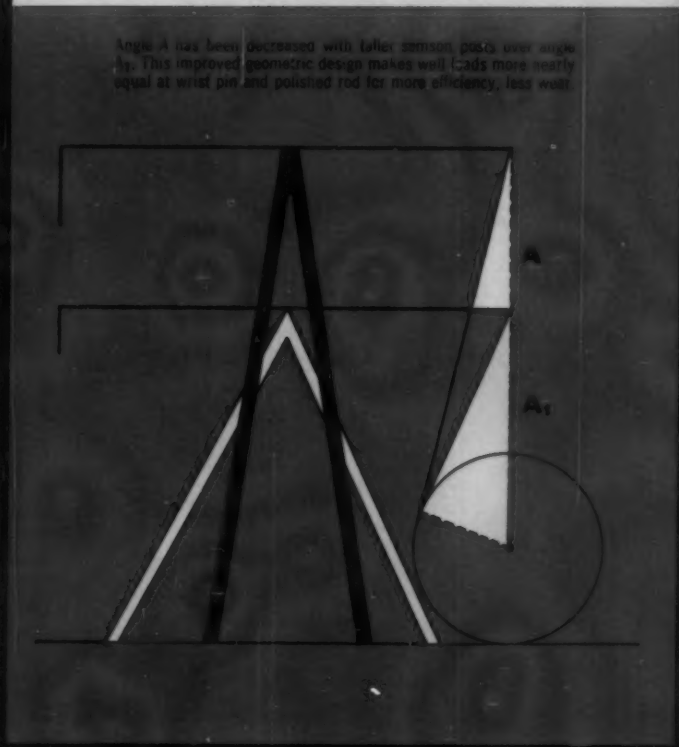

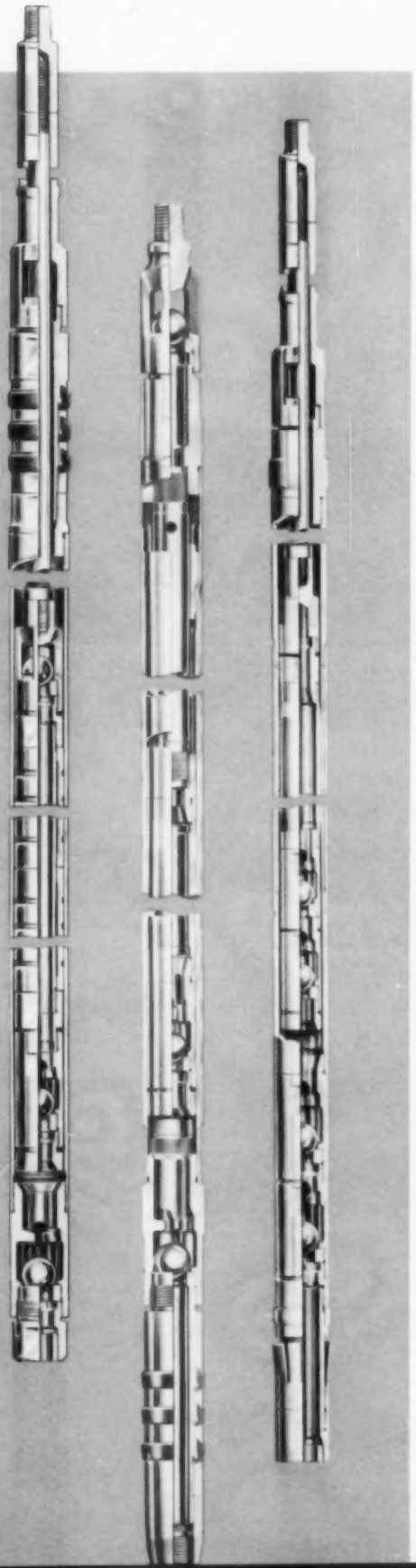

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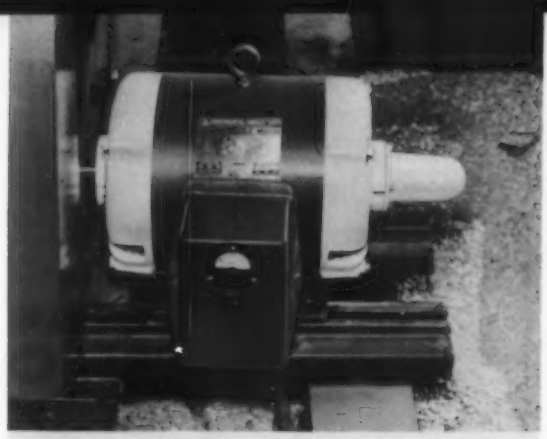

Standard C-E Green Triangle Motor

C-E Green Triangle Single Phase Motor, convertible to three phase

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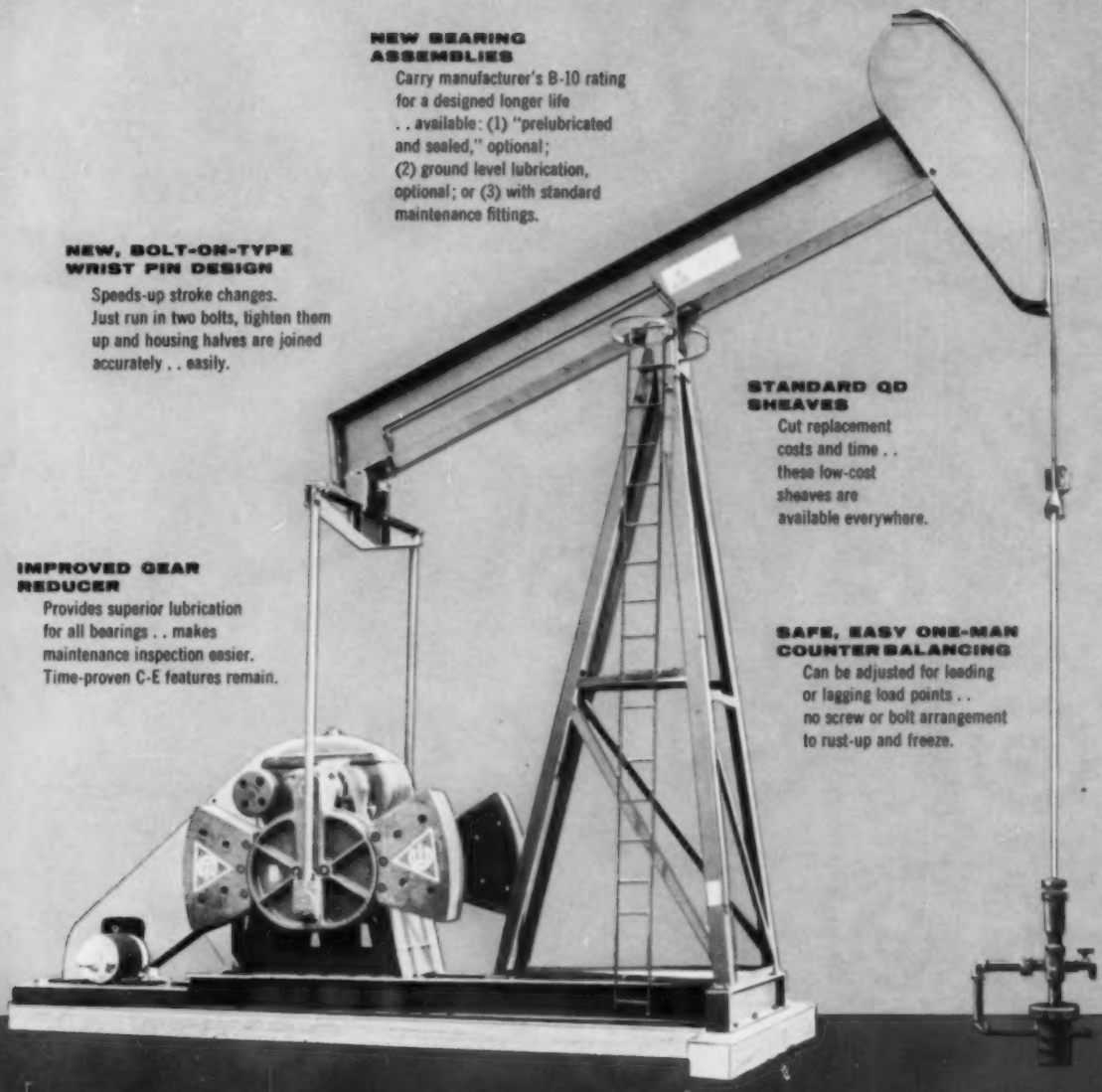

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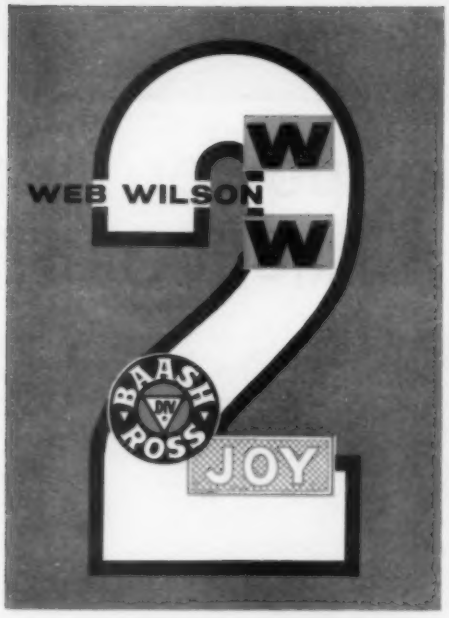

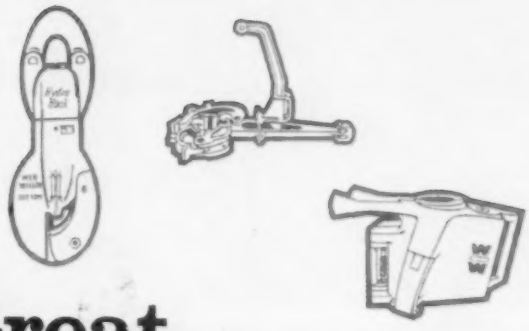

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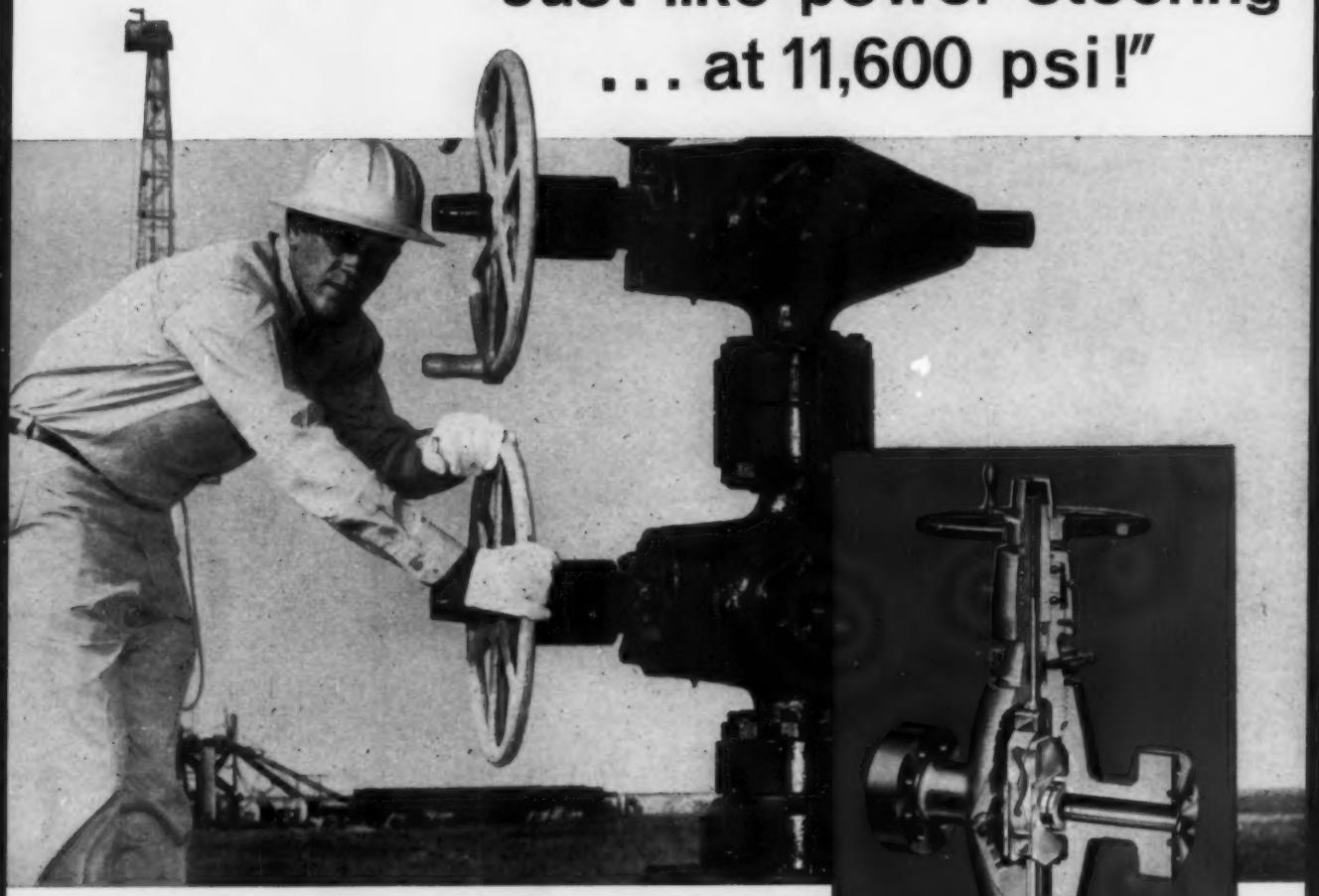

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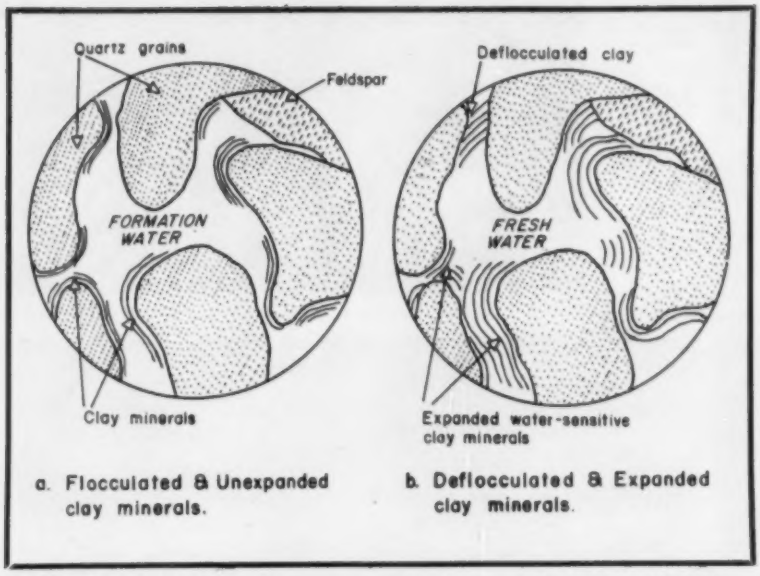

FIG. 8. Sketch of clay minerals in pore spaces of an oil-reservoir sand illustrates the deflocculation of the clay minerals, causing swelling of the minerals and resulting closure of pore channels.

expandable clay materials, and least developed in reservoirs containing kaolinite and non-expandable clays.

The amount of reduction of the pore space, and thus the permeability, will be determined by the percent of clay present and the total permeability of the sand. The unstable condition noted above would probably occur in waterflood operations in which fresh water is used. The presence of a comparatively small percentage of clay by weight will have very little effect in reducing the porosity. However, it might have a great effect on the reduction of permeability.[27]

Clay Content of Sandstone And Shale

Recent studies by Quaide[28] and Smoot[15] show a very significant contrast in the clay-mineral content of sandstones and their associated shales. Quaide, in an investigation of the clay minerals of Pliocene sediments from the Ventura Basin, California, notes a compositional difference between sandstones and shales. In both, illite, montmorillonite, and chlorite are present, but the percentage distribution is different. In the shale, montmorillonite or illite is the most abundant clay mineral, while in the standstone, chlorite predominates over illite and montmorillonite. The two sediments probably had a similar source, as evidenced by their intimate interstratification. He shows that it is probable that early diagenetic reactions were not the cause of the formation of chlorite. It is postulated that the difference in composition is the result of post-depositional changes brought about by "connate water" movement. The higher percentage of chlorite was developed in the sandstone by post-depositional alteration of illite and montmorillonite. However, little or no alteration took place in the shales, because the formation water was not able easily to penetrate the impermeable shale.

Studies by Smoot[15] of pre-Pennsylvanian sandstones in the Illinois Basin also showed contrasts between the clay mineralogy of the sandstone and shale. The shale samples he investigated were composed mostly of illite and chlorite which were well crystallized. The very shaly sands contained illite and chlorite with some partially degraded illite and chlorite. The clean sands (2 percent clay content) contained partially degraded chlorite and illite as the dominant component, with small amounts of well crystallized chlorite, illite, and kaolinite. The clean sands in the oil-producing portions of the formations studied showed higher percentages of degraded minerals than did the non-producing parts of the formations. In general there appears to be an increase in the degradation of the clay minerals, moving from the shale to the non-producing portion of the sandstone.

Smoot believes that these contrasts in clay mineralogy are the result of contrasting permeabilities and changes in the composition of the formation fluid. This resulted in the alteration and degradation of the clays in the permeable portion of the formations. This recent study indicates that changing environmental conditions in the permeable reservoir sands may change the character of the clay minerals from stable to unstable and the more unstable clays may be present in oil-producing portions of the formation.

Relation of Clay to Formation Water

The intimate association of interstitial water with clay minerals in reservoir sands causes it to be of great importance in the production of oil. Interstitial water in the petroleum reservoir is found absorbed on mineral grains or held in finer openings by capillary pressures.[29] Interstitial-water content at capillary equilibrium depends in part upon the number of grain contacts, size of pore spaces, and area of mineral surface exposed to the water.[24] The amount of interstitial water generally increases with a decrease in permeability and porosity.[29] A fine sand will hold more interstitial water than will a coarse sand, due to finer pores, greater number of grain contacts, and greater surface area per unit volume.

The clay-mineral content of the reservoir sand increases the interstitial water content by affecting the grain-size distribution of the sand and by the binding of water on the clay surfaces. Presence of the clay brings about higher interstitial water content. Clay minerals in the reservoir also contribute to an increase in the hydophilic wettability of the sand because of their attraction for water. Presence of clay would, therefore, cause the sand-grain surfaces to be more water-wet than the same sand with no clay.

Relation of Clay to Compressibility of Sand

Johnston[24] points out that sand bodies containing appreciable amounts of clay minerals may be compressed by overburden pressures, especially when many clay particles are present between adjacent sand grains. Compaction of the clay minerals and, thus, the sand body is mainly the result of pressures causing a reduction of the adsorbed and interlayer water. Compaction of a dirty sand in this manner may cause an increase in the production of oil and gas, because of a reduction of pore space as the oil or gas is withdrawn.

Compaction in some areas frequently results in overburden subsidence. At Lake Maracaibo, Venezuela, and Long Beach, California, subsidence of the overburden frequently has taken place where extensive oil has been withdrawn from arkosic sandstone reservoirs.[24]

Investigation by Thomson[30] of the Green Pond Conglomerate (Silurian) in New Jersey has shown that both pressure and solutions acting on the illite clay content of the formation have

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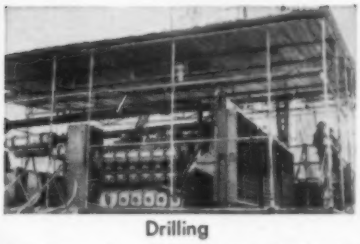

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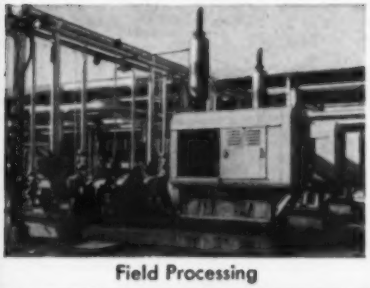

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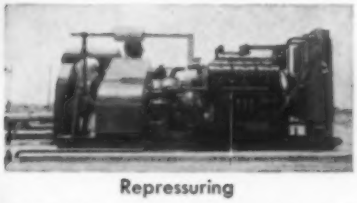

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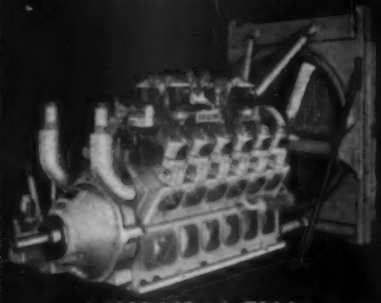

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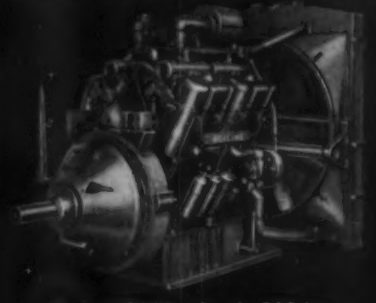

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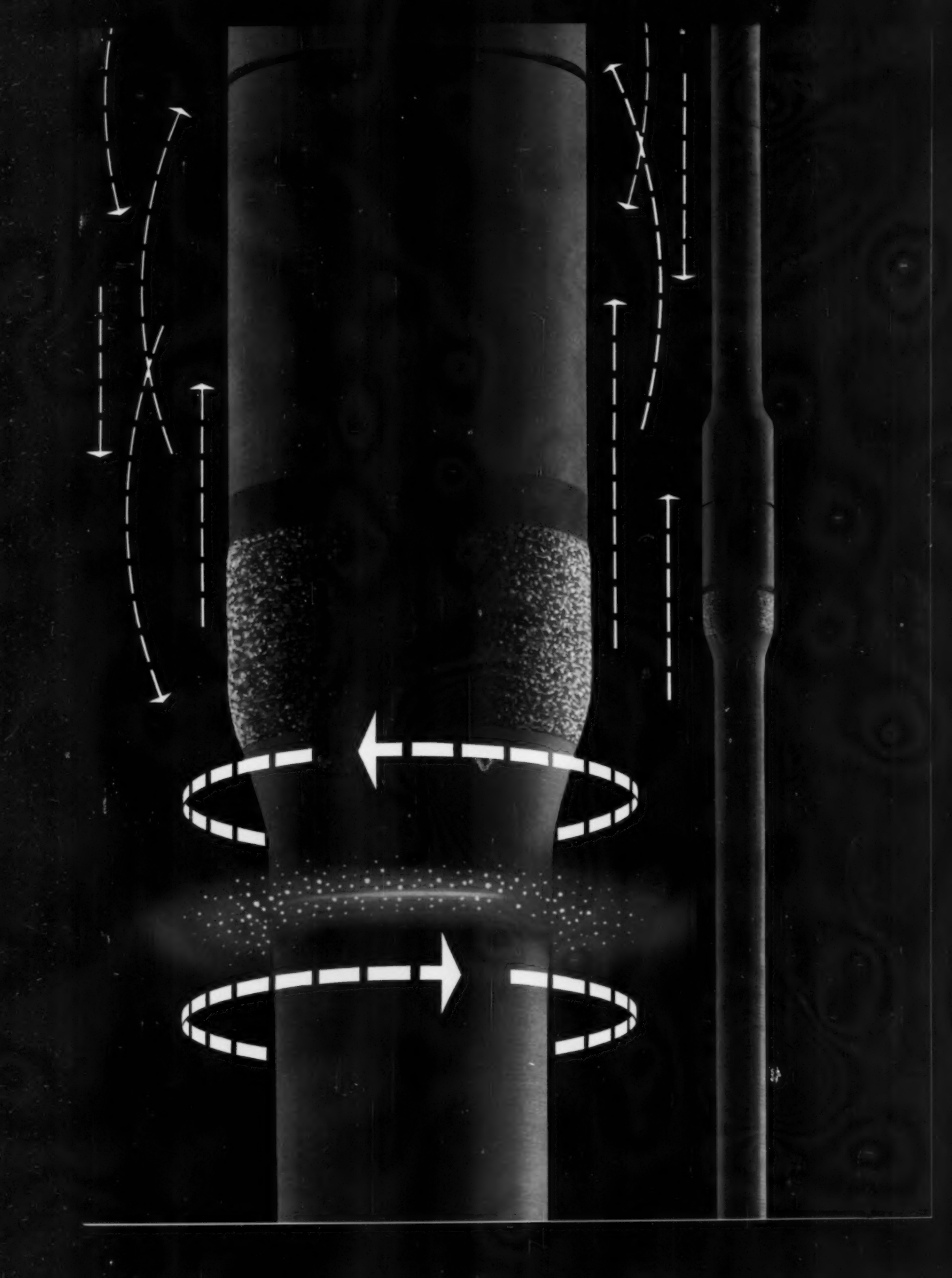

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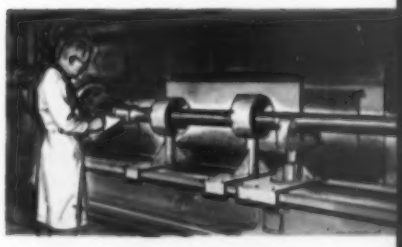

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resulted in a loss of the initial porosity. Solutions (formation waters) moving through the formation contained CO_2 and various cations which were able to effect ion-exchange reactions with the clay mineral. A strong alkali (K_2CO_3) is formed when the K cation of the illite is exchanged for ions in the formation water, which results in an alkaline pH at the points between grain contacts. He believes that, as a result of greater weight of overburden, increases in pressure and solution will occur and a point will be reached at which the quartz will be dissolved, due to the increase in pH. As a result of this action, initial porosity is reduced by interpenetration of grains and by the filling of the pores by secondary silica cement.

CLAY-MINERAL EFFECTS ON RESERVOIR SANDS

The clay-mineral content in reservoir sand pore space, due to its intimate association with formation water and petroleum, has, as shown in the previous discussion, a very significant influence on the character of the reservoir. The most important factor to consider in this association is that the clays in the reservoir react to environmental changes with respect to water and its dissolved ionic content. Flow capacities of the reservoir sand containing clay minerals will, therefore, depend on the type and amount of clay present in the sand and on the water in contact with them.

Effect of Clay Minerals on Fluid Flow

Permeability may be defined as a measure of the ability of a reservoir rock to transmit fluid in the interconnected pore network. Factors that influence permeability are grain size, degree of lithification, and both the type and amount of clay present.[3] Laboratory calculation of permeability may be made by using Darcy's equation. This equation states that the rate of flow of a homogeneous fluid through a porous medium is proportional to the hydrologic gradient and inversely proportional to the viscosity of the fluid. The assumption often is made in using this equation that no reaction takes place between the porous medium and the flowing fluid. However, this assumption is not justified when clay minerals are present, because in many instances they do react with the fluid.

Many investigators[6,11,24,32,33] have noted big differences in permeability values of cores containing clay minerals, depending on whether air, fresh water, or formation water is used in the test. Results of these studies have pointed out that cores show greater permeability to air than to brines and more permeability to brines than to fresh or distilled water. Morris and others,[6] in a study of oil-bearing sandstones, showed that the average permeability of cores decreased from 16,000 millidarcys in air to 620 millidarcys in salt water and 120 millidarcys in fresh water. Fig. 9 illustrates the air, brine, and fresh water permeability of the cores studied by Morris and others. Further, Johnston and Beeson[22] pointed out that permeabilities of cores to brine decreased as the concentration of the brine was decreased. Fig. 10 illustrates this relationship.

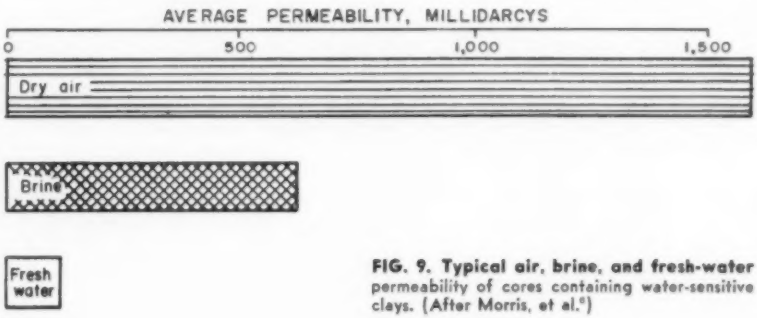

FIG. 9. Typical air, brine, and fresh-water permeability of cores containing water-sensitive clays. (After Morris, et al.[6])

The difference between permeability values using salt water and fresh water is controlled by the following interrelated factors: Type and amount of clay present, permeability of sand, and ionic composition of the fluid. The study by Baptist and Sweeney[34] indicated that the reduction in permeability of reservoir sandstones was due to one or more of the following clay properties: Base exchange, clay-water properties, and flocculation. They pointed out that these properties are shown in a marked degree by montmorillonite, in a lesser degree by illite, and in a relatively unimportant degree by kaolinite. Their research indicated that the sandstone cores studied contained kaolinite, illite, and mixed-lattice clay minerals were the most sensitive to changes in the chemical composition of the induced water and thus would cause the greatest reduction in permeability when fresh water is used in permeability tests.

Von Engelhardt and Tunn,[11] in an investigation of the reduction of permeability using an artificial mixture of quartz sand and 4 percent clay, noted the largest reduction of permeability

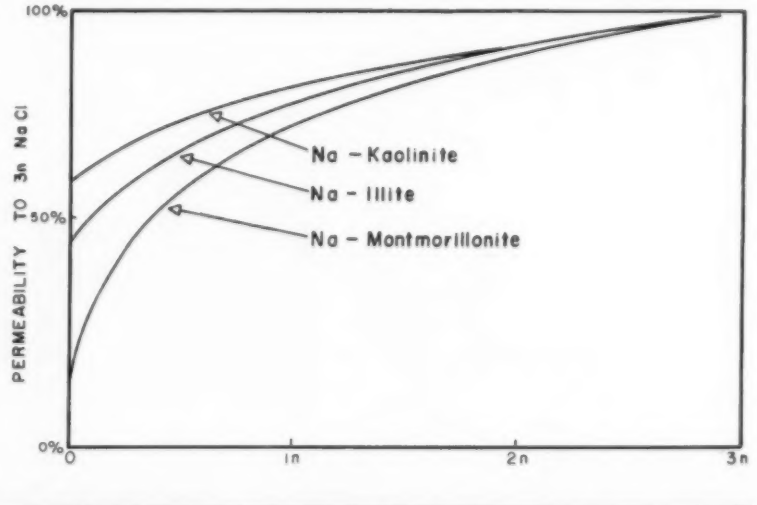

FIG. 10. Plot of reduction of permeability to saline solutions of mixtures of quartz sand with 4-percent clay. (After Von Engelhardt and Tunn.[11])

with dilute polar fluids and no reduction in the case of non-polar fluids. They indicated that reductions in permeability of cores containing clays were the result of both intercrystalline swelling and the holding of a relatively large volume of rigid water near the surface of the clay particle. Further, these investigators indicated that the clay minerals could hold a greater amount of bound or fixed water as the salt concentration is decreased, or, in other words, the less saline the water, the greater will be the reduction of permeability.

The importance of base-exchange reactions on clay minerals and their effect on the permeability of the reservoir sands was pointed out by Grim.[3] If fluid containing sodium in certain concentrations moves through a sand containing montmorillonite with calcium as the exchangeable cation, a condition of non-equilibrium would be set up and the clay mineral would respond to this environmental change by a base-exchange reaction. Sodium in the fluid probably would be exchanged for calcium on the clay surface. As a consequence of this cation exchange, the clay-water relationship would no longer be stable. The result of such a reaction would be the development of a new clay-water relationship which would probably cause an expansion of individual flakes, splitting of particles, and deflocculation of the clays from the quartz grains. Kaolinite, due to its stability and low cation exchange capacity, would be little affected by this action. However, illite, chlorite, and mixed-layer clays, because of their higher cation-exchange capacity and lower stability, will be affected to a greater extent by such a change, but not to the same extent as montmorillonite. Grim also pointed out that there would be little if any reduction in permeability if the montmorillonite clay had sodium as the exchangeable base or, similarly, if a calcium montmorillonite came in contact with a fluid containing calcium.

The relation of the absolute permeability of the reservoir sand to the effect of clay-mineral plugging was discussed by Baptist and Sweeney.[34] They concluded that the lower the value of absolute permeability, the greater would be the effect of the expansion and deflocculation of the contained clays. Sands having low fluid permeabilities would generally have a fine pore structure and, therefore, would be more or less completely plugged by expanded and deflocculated clays. Since a great many successful waterfloods are conducted in sandstones having a relatively fine pore texture, even a small percentage of water-sensitive clays would control the perme-

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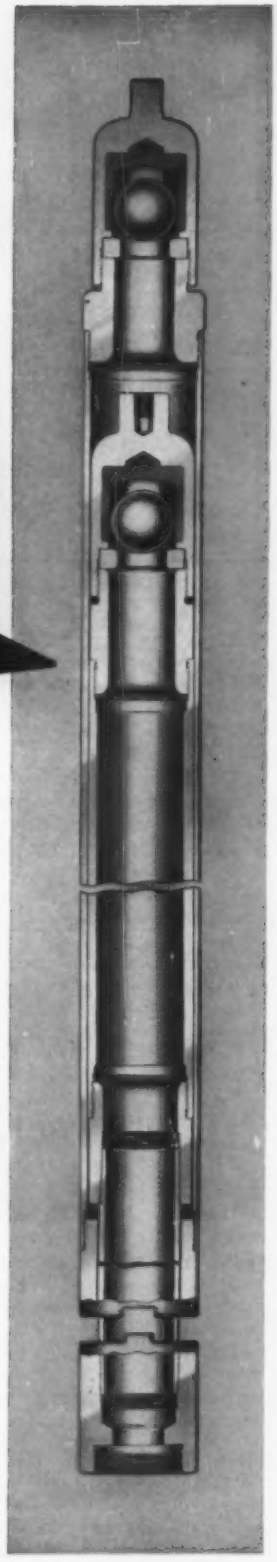

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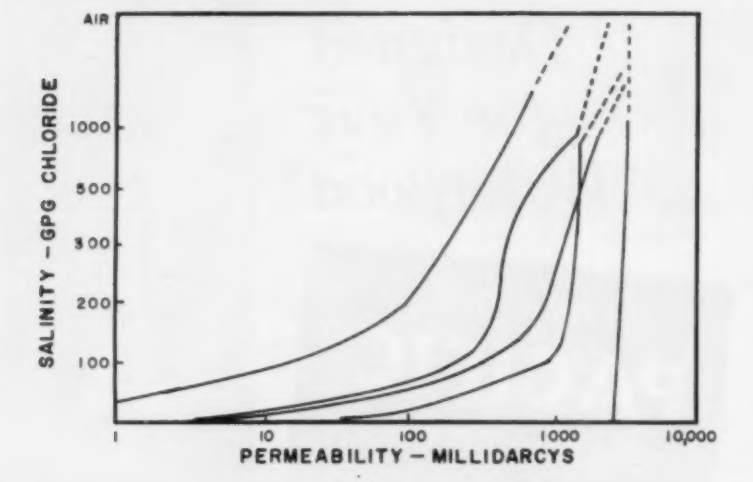


FIG. 11. Permeability of sample cores to varying salinity. (After Johnston.)

ability of the reservoir.[35] Sands of higher permeability would be able to contain higher percentages of sensitive clays before showing serious decrease in permeability.

The most notable failure made in the past by investigators of clay minerals in reservoir sands has been not to relate the permeability anomalies to specific clay minerals, but to attribute this phenomenon to the presence of "bentonitic clays." Recent investigations have shown that the following clay minerals are the most sensitive to the hydrogen-ion concentration (pH), types of ionic content, and concentration or ions of the water in contact with them: montmorillonite, degraded illite, degraded chlorite, and mixed-lattice clay minerals. These clays may be designated as water sensitive because they have a great affinity for water, the adsorption of which causes swelling, and are easily dispersed by deflocculating ions. The action of these water-sensitive clays, composing less than 4 percent of the reservoir sand, may affect the physical character so completely that virtually no recovery of oil is possible.

Following are the possible causes given to account for the reduction in permeability of reservoir sands as a result of clay reactions:

1. Type of clay mineral in sand — Montmorillonite, mixed-layer (illite and montmorillonite), degraded illite, and degraded chlorite are designated as water-sensitive clays because they are the clays most susceptible to damage by exposure to water and, therefore, cause the greatest decrease in the permeabilities of reservoir sands subjected to water of different saline content. Montmorillonite and mixed-layer clays of illite and montmorillonite are the most water-sensitive. Kaolinite, illite, and chlorite are much less water-sensitive than the clays listed above, and, therefore, would cause a much lower decrease in the permeability of the sand.

2. Nature of the exchangeable cation — Clay minerals with sodium as the exchangeable cation will show the greatest reduction of permeability, as a result of a decrease in the salinity of the flowing water. Clay minerals with Ca^{++}, Mg^{++}, or H^{+} as the exchangeable cation will have less effect on the permeability of the sand. However, if a base-exchange reaction takes place between clay particle and fluid containing a high concentration of Na cations, the permeability of the sand will be greatly reduced, especially if the clay is water sensitive.[3]

3. Reaction of clay — Water-sensitive clay causes a decrease in permeability as a result of swelling of clay due to adsorption of water between the plates, deflocculation of the clay particles from sand grains, and development of oriented water layer on the outer surface of the clay plate. It is probable that the greatest decrease in permeability is caused by clay swelling.

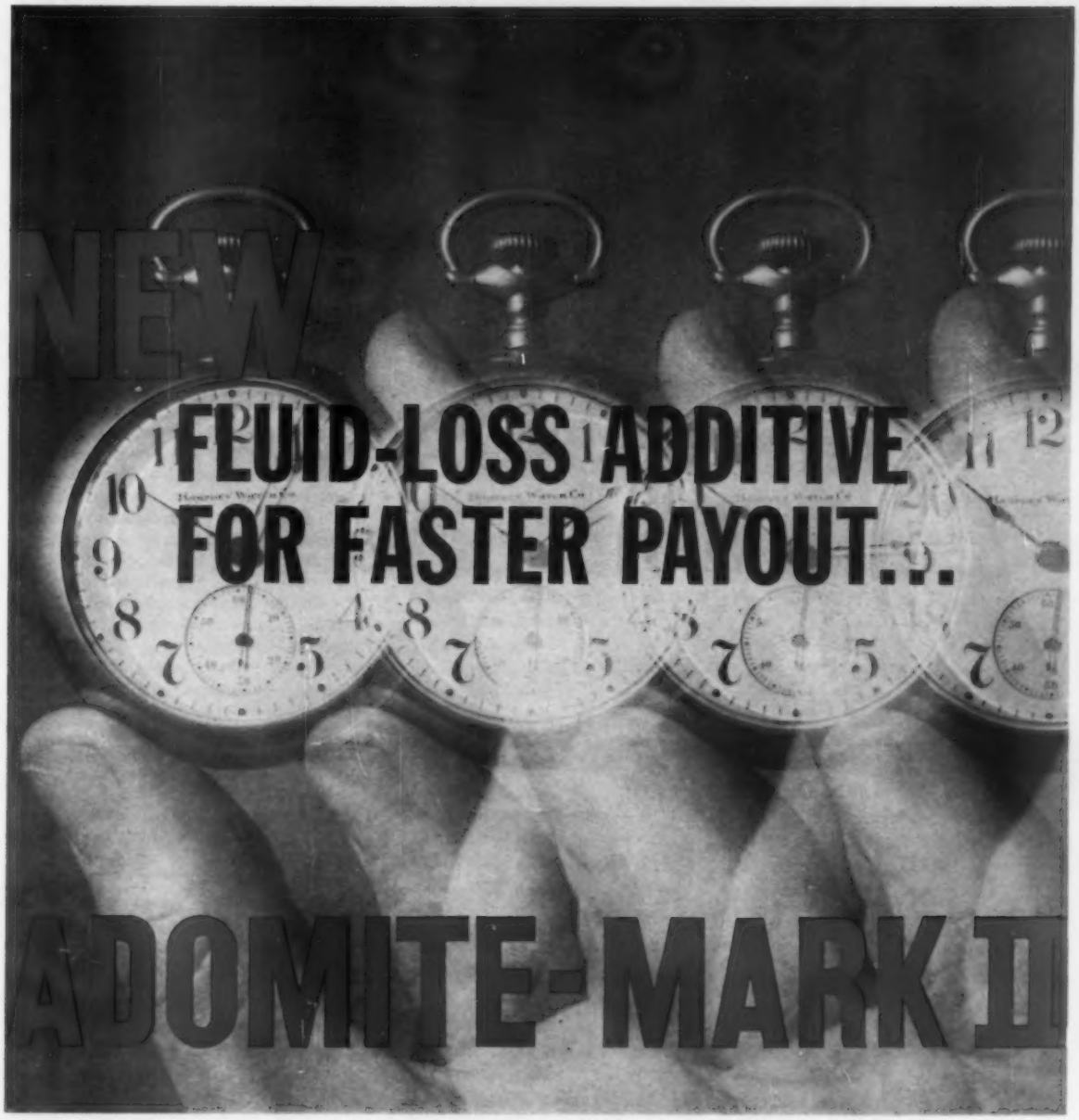
4. Salinity of the water — Permeability of sand containing sensitive clay will increase as salinity of the flowing fluid increases, Fig. 11.[11] The sands are least permeable to fresh water and most permeable to brines.[6] However, the cation content of the fluid should be compatible with the cation content of the clay, for if not, base-exchange reactions may occur to cause a decrease in the permeability. The results of many studies indicate that the brines produced simultaneously with the oil from the reservoir will cause little or no reduction in permeability, because these clay minerals will be in equilibrium with these solutions and their character will not be changed. Oilfield brines will, therefore, cause the least reduction in permeability.[21] However, a reduction in permeability will result if the electrolyte content of the clay and water are not compatible.

5. Percent of clay mineral — Permeability of a reservoir sand will be a direct function of the amount of clay in the sand. A dirty sand with a high concentration of sensitive clay minerals will be the most sensitive to the water content and will, therefore, show the greatest decrease in permeability if the equilibrium of the clays is upset.[24] However, a reservoir sand with only 1 to 4 percent sensitive clay content may also show a great decrease in permeability to fluids and a low percent of sensitive clay minerals would also exhibit an important effect on permeability in sands with a fine pore structure. Reservoir sands with high absolute permeabilities and low clay content and non-sensitive clays (kaolinite) will not have their permeabilities decreased by the clays.

6. Distribution — Sands having low permeabilities would have a fine pore structure and would be more or less completely plugged by expanded and deflocculated clays. Sands of higher permeability values would be able to contain a higher percentage of sensitive clays before showing a serious decrease in permeability.

Water Sensitivity of Clay And Waterflood Performance

The recovery of oil in a secondary recovery or pressure maintenance operation by the use of waterflooding will depend to a large extent on the permeability of reservoir sands. It has been shown that almost all reservoir sands contain clay minerals and interstitial water. Before the reservoir is drilled, these clay minerals are in equilibrium with the interstitial water present which is saline in character and contains ions of both alkali and alkaline earths.[26] During drilling and water-injection operations, waters of lower salinity and of different chemical composition than the formation fluids may enter the reservoir sand. This action may disrupt the equilibrium of the clay-interstitial water system if the clay minerals present in the reservoir sand are of the



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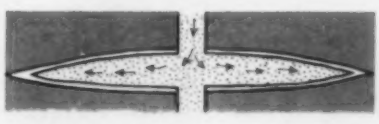
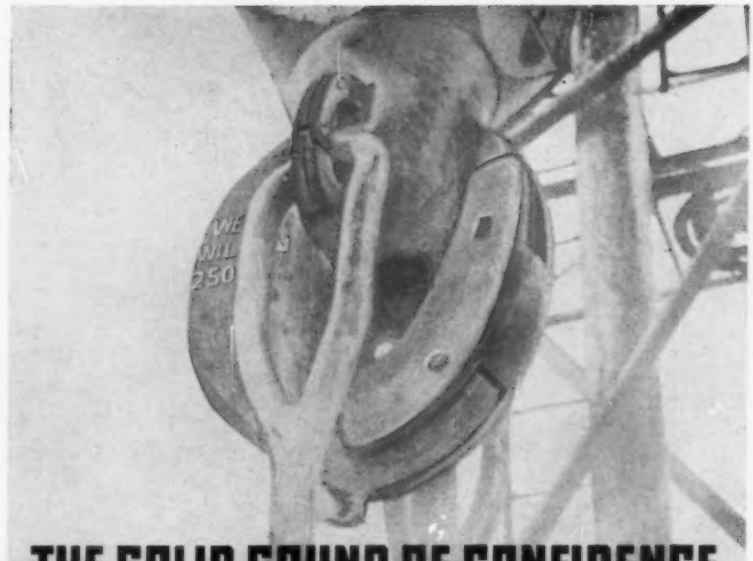
ADOMITE®  *. . . fluid-loss additives*



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water-sensitive type. The rate of flow of water from the injection well bore will be greatly reduced, due to the partial or complete blocking of the capillary openings in the sands, resulting in excessively large injection pressures.

Detailed investigations of the relation of water-injection well indices and laboratory studies of core permeabilities have received considerable attention in recent years.[6,14,17,21,23] All of these workers have emphasized the importance of using brine rather than fresh water in waterflooding operations.

Hughes and Pfister[21] made a comprehensive study of water-injection rates, as affected by the saline content of the water, for the benefit of waterflooding operations. Both the laboratory and field data indicated that injection rates increased with brine and decreased with fresh water. In general, the best water for secondary-recovery purposes is the subsurface brine originating in the sand, because this water keeps the clays flocculated.

Studies of clay minerals in four California reservoirs made by Nahin and others,[23] using many identification methods, found that the Stevens sandstone was susceptible to damage by fresh water because it contained water-sensitive clays of the illite and montmorillonite type and that, on the other hand, the Grotchell sandstone was relatively immune to fresh water damage because it contained predominately ka-

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From 1953 to 1954, Moore was employed as assistant geologist with American Zinc, Lead, and Smelting Company. During the summer of 1957, he worked with Sohio Petroleum Company in Houston, and during the summer of 1958, he was research assistant to Dr. Jack L. Hough of Great Lakes Institute.

olinite. The X-ray data indicated also that there was a possible connection between the amounts of montmorillonite clay present and the water sensitivity of the sand.

Dodd and others,[17] in an X-ray diffraction study of 90 core samples from reservoir sandstones, point out that few workers relate the effects of water sensitivity to specific clay minerals. The results of their investigations indicate that water sensitivity is a function of the concentration of the glycerol-expandable three-sheet clay minerals. The non-expandable kaolinite and illites would not cause serious water-sensitivity effects because they do not react to fresh water entry into reservoir sands.

Formation brines are compatible with water-sensitive clays because they most closely approximate the interstitial water present in the reservoir sand. The characteristics of most produced brines and interstitial waters are: Neutral to weakly alkaline pH, high salinity concentration (3 to 10 times that of sea water), reducing Eh, and the most common cations are sodium, potassium, calcium, and magnesium. On the other hand, fresh water has an acidic pH, an oxidizing Eh, and a very low concentration of cations. In the case of the formation brines, the water-sensitive clay minerals are in equilibrium, but with fresh water they are not. Grim[3] emphasizes that some brines may not always be compatible with clays and such brines may cause clogging. If the brine has a high concentration of Na, this cation may be transferred to the clay by base-exchange reactions, causing the clay to become more water sensitive.

Several recommendations have been made by investigators for controlling the clay minerals in reservoir sands by the addition of chemicals to the injection water. Johnston[24] points out that the best injection fluids to use are those containing a high concentration of soluble calcium salts. Examples of improvement of permeability by the addition of hydrochloric acid to injection water have been shown by Anderson and Heck[14] and Johnston.[24] Sensitive clay minerals which have swollen by hydration were treated with hydrochloric acid, which resulted in a base-exchange reaction, converting the clays to non-swelling hydrogen forms. Johnston indicates that reactions of fresh water on the acid forms of the clays is not serious as long as the fresh water does not have high sodium-salt content.

Caution is urged by several authors[12,15,24] in the use of certain surface-active agents (such as sodium hydroxide) in waterflooding operations. These investigators point out that these agents may remove the organic material coating the clay and, since the clay is no longer protected, the water may then expand or deflocculate the clay minerals.

Following is a partial list of the factors to be considered in carrying out a waterflooding operation or pressure-maintenance operation:

1. The character of the clays present in the formation should be determined with respect to the types, cation-exchange capacities, chemical composition, percentages, expandability, and mode of occurrence.[17]

2. Injection waters should be carefully studied with respect to chemical compatibility with the clay minerals and the interstitial water.

3. If the injection fluids are chemically treated, tests should be run to see that this treatment does not bring about a reaction with the sensitive clays. Certain chemicals (hydrochloric acid, calcium salts) may be added to control the water-sensitive clays.

4. The best rule to follow as to the type of injection fluid to use is to select a brine that most closely approximates the chemical composition of the indigenous formation water and, if possible, to avoid using fresh water unless clays are completely insensitive.[3]

5. Permeability tests should be run on cores from the producing portion of the formation, using the fluids that have been planned for injection.[6]

Effects of Drilling Muds And Clay Reactions

Either the clay minerals or the fresh water used in drilling muds may filter into pore channels of the producing portions of the oil formation and may cause plugging of pore spaces. The muds used in drilling operations are usually composed of deflocculated three-layer water-sensitive clay minerals, such as Wyoming bentonite (montmorillonite).[36]

Laboratory studies indicate that these clay particles may penetrate core samples and thus greatly decrease the permeability. Beeson[37] and Norwalk and Krueger[38] found that a sandstone that is normally free of clay may be plugged, thus adversely affecting the productivity of the well, as a result of contamination of the permeable sand by clay particles from the drilling mud.

The influence of the fresh water in water-base muds and their effect on reservoir sands have been studied by many investigators.[24,38,39,40,41] If water-sensitive clays are present in the producing sands, the entry of fresh water from the muds may cause reaction which will effectively block the flow of oil to the well bore. Johnston and Sherborne[39] reported that severe hydration of an oil-producing formation caused

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a drastic decrease in the well productivity and the productivity index of some wells decreased the longer the drilling fluid stood against the formation. Comparisons which were made between production figures using oil-base muds and water-base muds indicated that the use of oil-base drilling fluids showed much higher average initial productivities, with as much as a 2:1 improvement in some wells.[42] Observations by Kelley and others,[40] Radford,[43] and Wade[41] indicate that there is damage to the permeability of the reservoir sand near the well bore by fresh water invasion and that the damage will be greater as more water invades the formation. Laboratory studies by Norwalk and Krueger[38] indicate that in cores the decrease in permeability to oil is more the result of interaction of fluids with water sensitive cores than that caused by the invasion of mud particles.

Kelley, Ham, and Dooley[40] recommend the following methods of obtaining maximum well productivity when drilling or working a productive zone: Minimize the water entry into the sand, add salts to water permitted to infiltrate, keep time of contact of drilling fluid on productive sand to a minimum, and use chemicals for treating mud that will have a minimum effect on water-sensitive clays in the sand. Hughes[13] suggests further that it is advisable to use no water in a well that would deflocculate clay minerals during drilling, completion, cleanout, and workover of a well.

Damage to well productivity done by drilling muds increases with the amount of water invasion, time of mud contact, greater mud-cake penetration, and the extent of the damage depends primarily on both the amount and type of clay minerals present in the reservoir sand.[36] Therefore, studies in the fields of waterflooding and well completion indicate the importance of knowing the type of clays in the reservoir sands and the effect of injected fluids on the behavior of these clay minerals.

METHODS OF STUDY OF RESERVOIR CLAY MINERALS

Recent advances in the methods used to study clay minerals have provided techniques by which the behavior of clays in the reservoir may be predicted. An investigation of the relation of clay minerals to reservoir performance should, in planning a waterflood operation, consider characteristics of the clay minerals in the producing formation in regard to their type, percentage, cation-exchange capacity, ability to expand, relation to the pore space, and organic coating. In addition, very careful attention should be given to the portion of the producing formation from which the sample is taken, the way in which the core is obtained, and the method by which the sample is prepared for laboratory study.

Core samples selected for this type of study should be collected from points in the interconnected pore spaces of the sand and not from impermeable portions of the formation or isolated shale streaks.[17] It may be advisable to study the clay mineralogy of samples from both the producing and non-producing wells in the area in order to detect changes in clay minerals. The overall factors of the clay mineral distribution also should be noted, because the water-sensitive clays may be found only in isolated portions of the reservoir, in which case it may be economically expedient to ignore the clay-water sensitivity problems there.

Basic techniques used for preparing clays for clay analysis and identification of clay minerals are given by Grim.[2] The following will be only a generalized discussion of the methods used. After the mud cake from the drilling mud is scraped from the core, a portion of the sample selected for clay identification is crushed and extracted with toluene. The extracted sample is then placed in distilled water and allowed to soak to remove the clay from the sand grains. If clays adhere firmly to the sand it may be necessary to add a deflocculant or use ultrasonic vibrations to separate the clay-mineral particles from the sand grains. It also may be necessary to add a solvent to some samples to remove organic material attached to the clays. Several oriented aggregate slides should then be prepared by wet sedimentation techniques. In this procedure the sample is stirred vigorously and allowed to settle and the desired grade size fraction is separated out. Thin sections and powdered samples of the clay minerals should be prepared from other portions of the core.

Determination of the character of the clay mineral can be obtained by several methods of analysis, such as X-ray, differential thermal, dye-staining, optical study, flame photometer, and chemical analysis. Studies of the expandable three-sheet clay minerals made by treating the oriented aggregate slide with glycerol and then obtaining an X-ray analysis have proved an accurate method of making predictions of the water sensitivity of the reservoir clay.[17] Differential thermal and/or X-ray methods are necessary to determine the clay crystal structure. Optical studies are used in the study of thin sections to observe the textural and mineralogical associations of clays to the sand particles and to estimate the percentage composition of the mineral components. Determination of the exchangeable cation composition of the clays can be made by use of the flame photometer and by chemical analysis, but, as pointed out by Grim,[2] an accurate analysis is extremely difficult. Differential-thermal methods can also be used to estimate the organic and clay content by an analysis of the powdered samples.[6]

Some of the major problems encountered in the study of reservoir clays are due to bonding of clays to the sand grains, organic matter coating clays, poorly crystallized clay minerals, and the small percent of clay that can be obtained for analysis. Frequently these clays are composed of complex mixtures of several clay minerals, and also mixed-layer structures. Further, many of the clay minerals found in producing portions of the reservoir are of the degraded type.[16] Therefore, their analysis is sometimes difficult, even by modern techniques.

Analysis of these sediments should involve the use of several complementary techniques, such as a combination of X-ray diffraction, differential-thermal analysis, chemical, and optical analyses, in order to obtain enough data for an adequate evaluation of the clay mineral and its properties. In addition, for a complete appraisal of the clay-mineral reactions, a core permeability test should be made to measure the effect of fluids of varying salinity and chemical composition.

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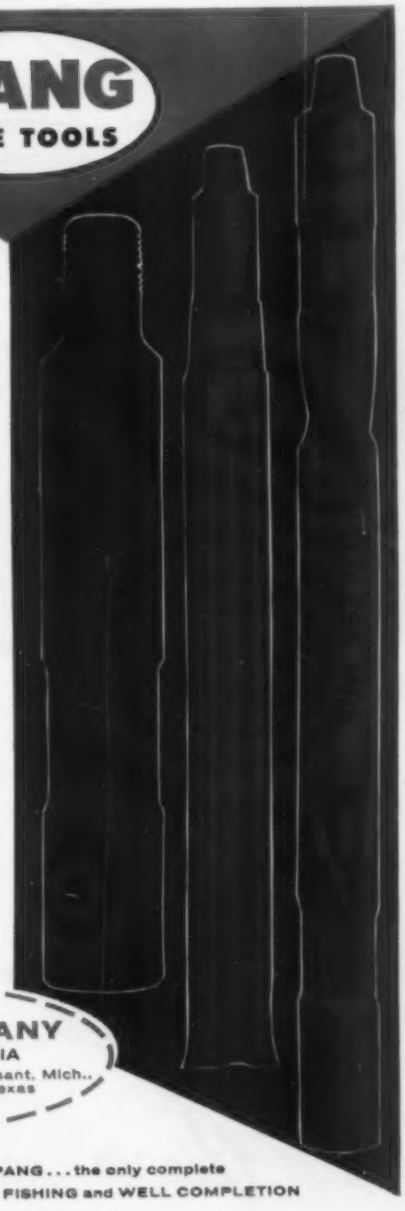

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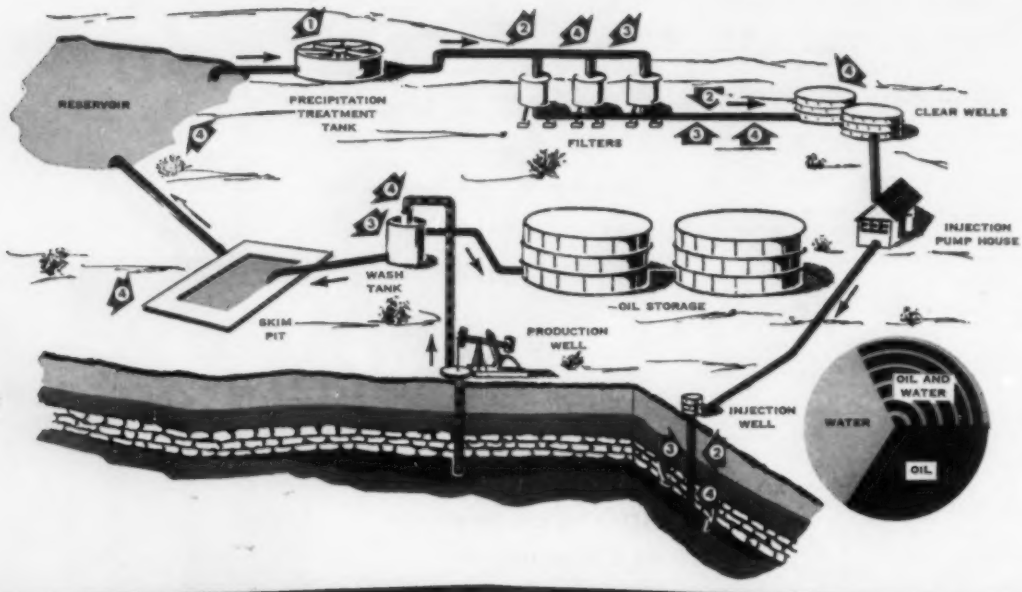

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THE EYES OF THE OIL INDUSTRY*

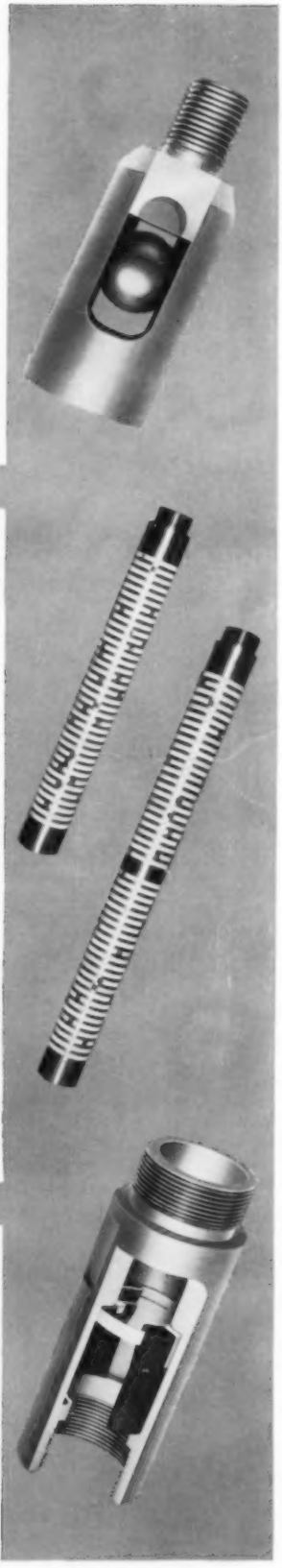
SCHLUMBERGER

**Sequential recording.*

Let Rubber Take The Wear

in your sucker rod pumps

It Costs You Less That Way



Both **MARTIN PLUNGERS** and **MARTIN RUBBER GUIDE CAGES** are the result of correct engineering to fully utilize the excellent properties of rubber.

In the **MARTIN SPLIT RINGS**, even the swelling of natural rubber in oil is utilized in sealing the split and tightening the rings in the PLUNGER GROOVES. **Resistance to abrasion** greatly prolongs plunger life in sandy conditions. **Slippery when wet** means that you have lubrication, even when pumping all water. Barrel life is increased because this material cannot score or gall metal.

For the **REPLACEABLE RUBBER GUIDES** in cages, **oil resistant** synthetic rubber is used. No swelling can be tolerated here. **Resilience** completely eliminates the beating action of the ball, and greatly increases ball life. **Resistance to abrasion** reduces wear on both guide and ball.

CUT YOUR COSTS . . . LET RUBBER TAKE THE WEAR . . . Write for our new 1960 catalog.

JOHN N. MARTIN

Manufacturer

9 W. BRADY STREET • TULSA, OKLAHOMA

RUNNING TOUR with MEN in the INDUSTRY

▸ Delhi-Taylor Oil Corporation of Dallas has announced personnel appointments in its special projects and planning division and production division. **Leland W. Carter** joined the company as gas engineer in

L. W. Carter

H. O. Stallings

the natural gas and pipeline department of special projects and planning. **Harold O. Stallings** has been named reserves and evaluation engineer in Delhi's production division.

▸ **Joe F. Moss** has been appointed district exploration manager of the South Louisiana district of Southwest Gas Producing Company, Inc. His offices will be at Lafayette, Louisiana.

▸ **H. R. Safford, Jr.** has been elected executive vice president of the Petroleum Equipment Suppliers Association. Safford, who maintains headquarters in Houston, has been executive secretary of PESA since 1946.

▸ **Lewis G. Weeks**, president of the American Association of Petroleum Geologists, announced the following recipients of honorary membership, to be formally presented April 26 at the 45th annual meeting of the association in Atlantic City, New Jersey. They are **Leonidas T. Barrow**, Houston, Texas; **Charles J. Hares**, Boulder, Colorado; **Roy T. Hazzard**, Rocksprings, Texas; **Samuel H. Knight**, head, department of geology, University of Wyoming, Laramie; **Robert B. Moran**, consultant, Pasadena, California; and **Edgar W. Owen**, consultant, San Antonio, Texas.

▸ **Weston Payne**, former Anderson-Prichard Oil Corporation vice president for production, has retired. Payne served with the company 29 years.

If you're looking for the veteran of veterans among oil company employees in the United States, William "Bill" Shepherd of Shell Oil Company would be among the leading candidates. Shepherd is Shell's senior employee in the United States. S. F. Bowlby, right, vice president of the Pacific Coast Area, presented him a 5-diamond service award — and this mock-up. Shepherd has been everything from office boy to roughneck, and is now auditor of disbursements for the area treasury department in Los Angeles.

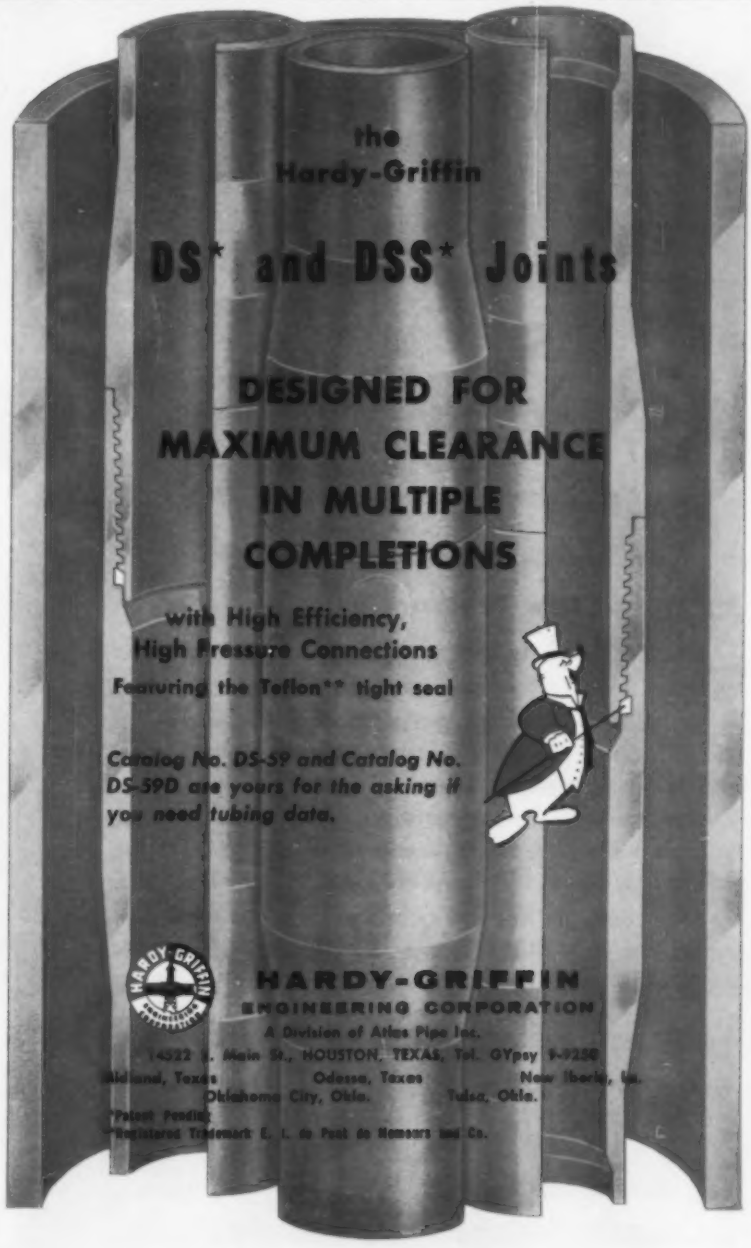
▸ **Henry V. Howe**, director of the school of geology, Louisiana State University, Baton Rouge, Louisiana, has been chosen to receive the Sidney Powers Memorial Medal, highest honor in petroleum geology.

Dr. Howe is the 13th recipient of this award, which was established by the association in 1943. The award is made in recognition of distinguished and outstanding contributions to or achievements in petroleum geology. The gold medal and scroll will be formally presented April 26 at the 45th annual meeting of the association in Atlantic City, New Jersey. The presentation will be made by **Harold N. Fisk**, Humble Oil & Refining, Houston.

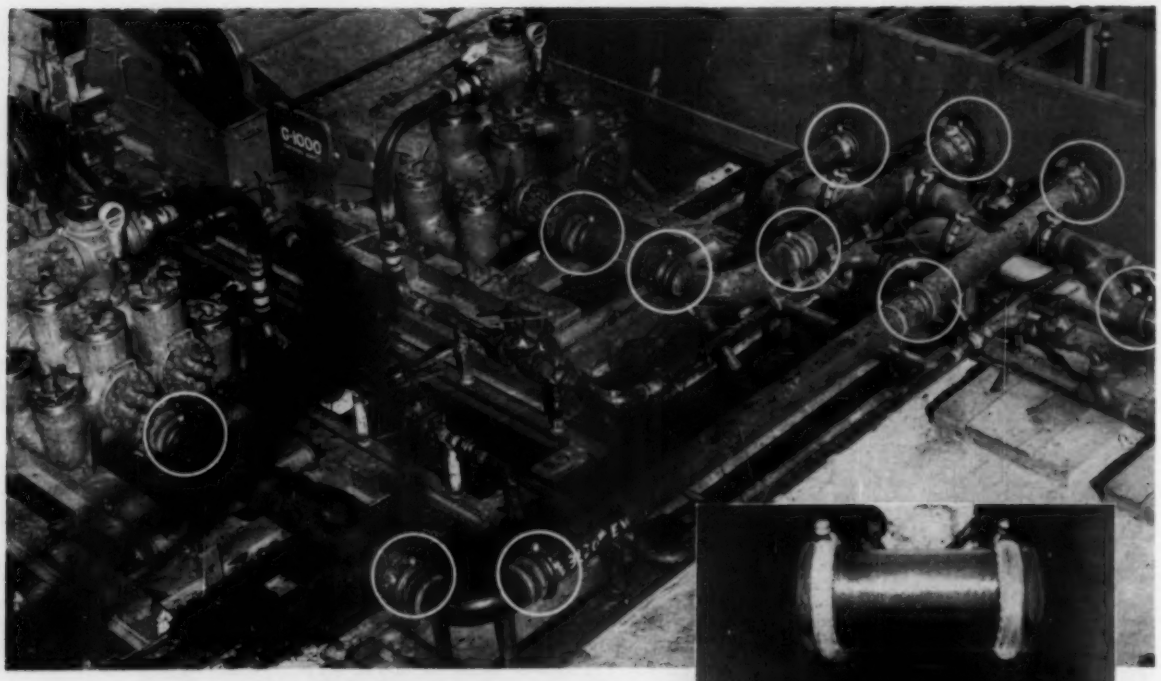
▸ **Murray B. Quigles, Jr.**, a Union Producing Company employee since 1946 and a member of the firm's Houston staff since 1956, has been promoted to district drilling and production superintendent, it was announced by **E. M. Smith**, the company's Houston district manager.

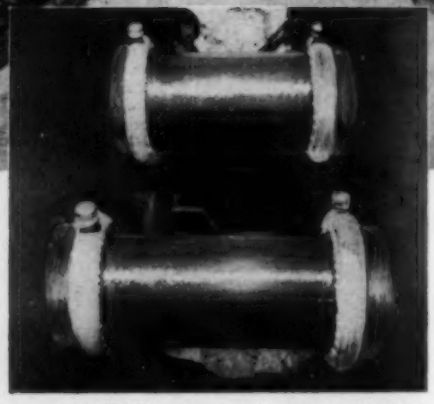
W. A. Walther Jr.

▸ **William A. Walther, Jr.**, assistant division production superintendent for the Houston division of Sinclair Oil & Gas Company, has been transferred to Tulsa as assistant division production superintendent for the Tulsa division.



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD





AIR-O-UNIONS on mud tanks and suction lines save hours of rig-up time. All you do is slip the pipe in place, inflate the tube and your suction lines are ready for service. (Inset) Installation of Air-O-Unions for compounding mud tanks.

The WECO AIR-O-UNION

PAT. PEND.

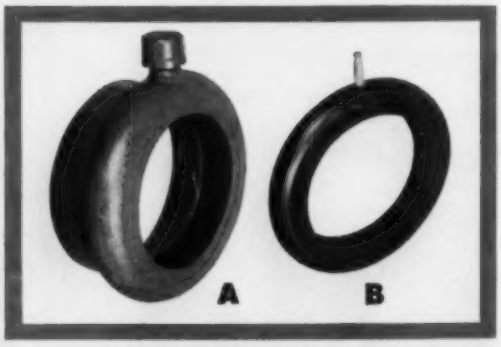
SEALS WITH A SHOT OF AIR

- **For Mud Suction and Return Lines**
- **For Low Pressure Fluid Lines**

AIR-O-UNIONS, now manufactured by WECO, are available from WECO and Chiksan representatives and supply stores throughout the world.

Air sealed Air-O-Unions give you a perfect seal on low pressure lines . . . make up fast and easy without close line-up . . . allow pipe expansion and mis-alignment without breaking the seal. No bolts, nuts, wrenches required . . . no threading or grooving is necessary . . . just use plain end pipe. Jab it through the union, inflate the tube and they're made up ready for service. To break out, just deflate the tube.

For efficient, low cost mud suction, mud return and other low pressure lines, install WECO Air-O-Unions. Ask your WECO Representative or your supply store.



AIR-O-UNIONS consist of only two parts, the union body (A) which is permanently welded in place, and the inflatable tube (B). Only replacement ever required is the tube. Sizes range from 6" to 18".

Switch to low cost, timesaving, simplified Air-O-Unions for all low pressure lines.

WECO

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS

Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

fmc

AO-2-59

YOU NAME THE MUD SPERSENE THINS IT.....

	Weight—lb./gal.	Viscosity—sec./qt.	Gel Strength—Initial/10 min. lb./100 sq. ft.	Fluid Loss—cc.
Gyp mud	19.0	63	0-3	3.9
Lime mud	12.7	53	0-0	5.0
Saturated salt mud	15.0	64	0-4	2.8
Sea water mud	10.8	40	1-4	7.4

The chart tells the story. Based on mud reports of actual drilling wells, it gives conclusive evidence that Spersene® controls viscosity and gel strengths in different types of drilling fluids. The facts prove that Spersene is highly effective in gyp, lime, and salty muds.

Spersene permits the use of high weight gyp muds for deep drilling. The low alkalinity of gyp-Spersene muds improves stability at high temperatures. And, Spersene is soluble in fresh and **salt** water.

Spersene is one more tool developed by Magcobar Technology. The Magcobar mud engineer knows Spersene, knows how to use it right for highest performance. He can help you plan your drilling program with Spersene for maximum economy.

So, wherever you drill, begin planning with Magcobar. You'll find that Magcobar Technology combines the finest engineering skills with high performance products to avoid costly trouble in drilling, to let you drill at the lowest cost per foot every foot of the way.

Magcobar
Complete
DRILLING MUD SERVICES

DRESSER INDUSTRIES, INC.
OIL • GAS • CHEMICAL
ELECTRONIC • INDUSTRIAL

MAGNET COVE BARIUM CORP.
HOUSTON

Well Done
With Magcobar
Technology

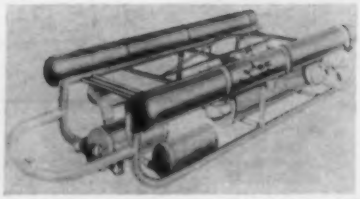
It's New

Drilling – Producing Equipment

Mobile Underwater Vehicle

A Mobile Underwater Vehicle System has been originated, developed, and constructed by VARE in conjunction with the U.S. Department of the Navy. The system is referred to as M.U.V.

Recently this system equipped with a closed circuit television camera chain was used for surveying the ocean bottom at 600 ft for locations and cable inspection.



Operation of the underwater vehicle is remotely controlled from the console on the mother ship by means of a multi-conductor cable. This unit is propelled and guided by means of 3 electric propulsion motors, gear connected to propellers.

The port and starboard units control the lateral motion fore and aft and also control the direction. This propulsion system is unique in that it permits the underwater vehicle to hover at any desired depth in currents or tides of several knots. This flexibility permits optimium usability of the underwater units for many and varied types of operation.

Offshore oil drilling operation applications include inspection of underwater cable and pipeline crossings, ship's hulls, sea walls, obstructions, and piers. *VARE Industries.*

Circle number (1) on reply card.

Always at your Supply Store

W. C.
NORRIS
SWAGED NIPPLES and BULL PLUGS

Safety . . . craftsmanship . . . durability . . . precision . . . yes, these elements are important in Swaged Nipples and Bull Plugs. And, these are the elements found in *all* W. C. Norris fittings — elements proven by the experience of our customers.

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NORRIS QUALITY OIL WELL SUPPLIES
Buy From Your NORRIS Distributor

Neoprene Thread Protector

A neoprene clamping device, the Klampon Thread Protector, provides protection to the threads of popular sizes and types of oil well casings.

It consists of a high-strength alloy steel band molded inside an oil-resistant neoprene protector, and an adjustable cam-type latch assembly for manual locking and unlocking of the protector around the external threads of the casing.

A spiral hook, incorporated in the latch handle, is used to return the protector assembly from the derrick. The thread protector requires no auxiliary equipment in its operation. The device is available only by rental within the United States. *Klampon Corporation.*

Circle number (2) on reply card.

Chemical Spray Washing

A new high-pressure Thermadraulic chemical spray washing system for use on oilfield equipment has been developed by Sprayaway.

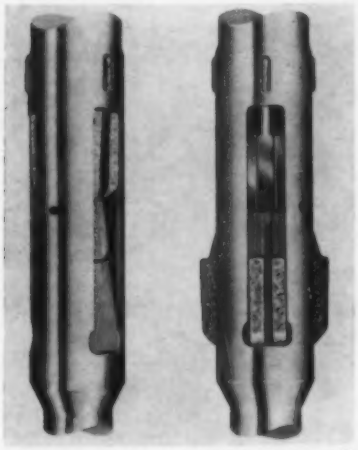
The unit is basically a specially designed instant heater combined with a 100 gal chemical tank reservoir and a high-pressure pump system. Unit is portable and may be used in the field or in the shop.

For field use, unit is propane-fired and the equipment is mounted on a heavy-duty I-beam skid. For shop locations the unit is natural-gas fired and employs a heavy-duty electric motor to power the pump.

The application of the heated chemical spray under high pressure cuts grease and oil deposits encountered in the oil fields. It can be used both on oilfield equipment and for cleaning rolling stock. *Sprayaway Corporation of America.*

Circle number (3) on reply card.

Section Mill



A new section mill built by Grant Oil Tools was designed exclusively for milling sections of casing in all weights and under all hole conditions, the manufacturer states.

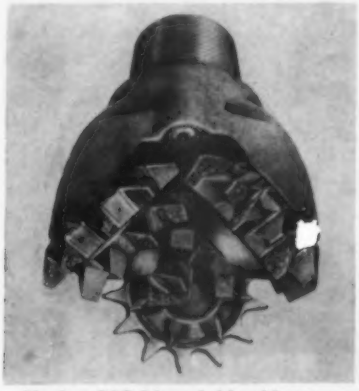
A basic feature of the Body Lock section mill is that the broad bases of the three cutter blades are locked tightly within the tool body during operation. This eliminates the danger of cutter arms bending or breaking off and prevents the blades from being collapsed by side pressure. It also permits the operator to apply greater weights for faster progress.

The mill combines both hydraulic and positive mechanical forces to activate the blades and hold them in maximum operating position. A hydraulically-impelled piston drives the cutters up the inclined planes of the wedge mandrel within the body pockets.

A blade guide feature of the cutters assures positive centering of all three blades during milling. *Grant Oil Tool Company.*

Circle number (4) on reply card.

Rock Bit for Top Formations



Hughes OSC-3A rock bit with conventional watercourses, and the OSC-3AJ for jet drilling are designed for faster penetration in top formations.

The bits use long, slim, strong teeth, and have several features added to drill softer formations. They have an increased tooth height for deeper bite.

Fewer number of teeth make contact on bottom, allowing a gouging-scraping action. Fewer heel teeth give more ventilation, increasing self-cleaning action. *Hughes Tool Company.*

Circle number (5) on reply card.

For long-stroke units . . .

Now a Two-Piece "Transportable" Rod Pump for Deep-Well Pumping

Here's a special long-stroke rod pump that's easily *carryable* to the lease. The H-F Transportable Rod Pump is designed for either hydraulic or beam unit pumping of deep wells. The barrel tube and pull rod, precision-machined and matched for an exact realignment, are broken apart and carried in two sections on the side of a car, then assembled for running in the well.

The pump is installed with a bottom lock hold-down in a standard lower seating shoe. A cup-type top hold-down seats in an upper shoe to stabilize the pump during operation. The upper hold-down also seals off the pump-tubing annulus from sand accumulation at the hold-down. The entire pump is strong and tough — sufficiently rugged to produce efficiently in deep wells.

The H-F Transportable Rod Pump, equipped with an 81-ring Flexite® Plunger, is available in 2"x1¼", 2½"x1½", and 2½"x1¾" sizes, with a 32' or 38' plunger stroke.

If you want to run a dependable rod pump — and get it out to the well at the very moment you're ready to run it — ask one of our factory representatives about this special new pump. Also ask the Harbison-Fischer man, your store, or write us at Box 127 for an illustrated bulletin, without obligation.

H-F WIDE DESIGN 'FLEXITE'® RINGS have three times the sealing surface of regular rings, but only twice the length...ideal for deep-well pumping.

HARBISON-FISCHER MFG. CO., Fort Worth

REPRESENTATIVES IN ALL MAJOR PRODUCING AREAS

"Best Pumps in the Oil Patch"®

new analysis shows how to-

cut drilling costs by $200 per day

If you are using mud as heavy as 12 lbs. per gallon, here is an engineering analysis that shows how you can cut mud costs by using a CLAYJECTOR®.

12-pound mud generally contains about 1½ sacks of barite per barrel. Every time you jet a barrel of mud, you lose barite as well as the clays you are trying to get rid of. This means a monetary loss of over $3.50 per barrel.

Now, if you use three steel tanks, you lose about 100 barrels of mud every time you jet down one foot. Since it is common practice with muds in the 12-pound range, to jet at least one foot per day, that means you jet away something like $400.00 worth of barite, oil and chemicals. With heavier muds, there will probably be less jetting. However, the greater amount of barite and chemicals per barrel means an even greater loss by jetting. You can avoid that loss if you use the CLAYJECTOR to process your mud — rejecting unwanted clays and retaining expensive barite.

Since you get more than 70 per cent clay rejection efficiency with the CLAYJECTOR, you need process only 140 barrels of mud to reject the equivalent of all the clay from about 100 barrels of mud. This low volume of fluid processed keeps oil and chemical losses at a minimum.

Because barite recovery efficiency is 80 to 90 per cent, you lose less than one fifth of the barite in the mud being processed — a negligible amount out of the whole system.

To summarize, you save over $300 for every 100 barrels of mud you would have jetted — if you use the CLAYJECTOR instead of jetting. *Even when you deduct the cost of the CLAYJECTOR, you still can save well over $200 per day.*

This example may not apply precisely to your conditions, but your nearby Swaco sales engineer is ready to help you estimate your probable saving. Call him for more information.

SWACO®

SALT WATER CONTROL, INC.

1809 Continental National Bank Bldg.
Phone: ED 2-4433
Ft. Worth 2, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

usi **Axelson** **PUMPING NEWS**

Multiple Completions Up 65%
Axelson Expands Special Products

2-ZONE PUMPS

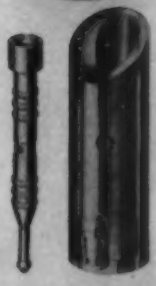
TWO-PACKER SINGLE STRING

Cross-Over Assembly

Least expensive for dual zone completions

SINGLE-PACKER DOUBLE-STRING

Clamped Tubing Cross-Over and Stab Joint Cross-Over Assembly



Most widely-used Axelson Two-Zone Pump, allows treating or gas venting the upper zone

ONE-PACKER TRIPLE STRING

Clamped Tubing Cross-Over

Used where the lower zone presents gas or corrosion problems. Both zones may be vented or treated.

As early as 1953 Axelson had a well-established Two-Zone Service Department when Texas was averaging less than 300 multiple completions per year. Now, with multiple completions up 65% over 1958, and running as high as 2200 per year in Texas, Axelson continues to expand its staff of full-time field specialists and engineers to handle the upswing of this type of completion.

Much has changed. Completions that once presented problems and seemed impractical are now considered routine due to Axelson's experience and advanced engineering design. Past complexities have been simplified and Axelson's know-how, specialized equipment and experience are available to all. Axelson's Two-Zone Department, now called Special Products Department, covers every multiple zone producing field in the United States and deals with both new completions and existing installations. They are also available to make recommendations on triple completions and slim hole duals or any phase of special multiple completion engineering.

Although their primary function is designing setups for multiple zone completions to take advantage of the production economies afforded by Axelson Two-Zone Pumps, Axelson experts work out production problems and make recommendations where one zone may be producing gas and the other oil, or where one zone is flowing and the other is pumping.

Axelson Two-Zone Pumps provide a practical, economical method of producing from two zones at once without commingling the fluids. Only one surface pumping unit is required, with a single rod string. All pump parts, with the exception of the cross-over assemblies, are standard, field proved parts, and the Two-Zone Pump itself is an insert-type pump, completely retrievable. A metal-to-metal seal is used for long life and dependability.

While the pumps themselves might be termed standard units, no multiple-zone completion can be called standard. No two wells present the same conditions, so each Axelson dual zone installation is in effect custom designed.

When an Axelson two-zone specialist is called in to discuss a multiple zone installation, he takes into account: pump depth (for both zones), casing size and length, tubing, water cut, gravity of the oil, desired production and the gas/oil ratio. The surface pumping unit—peak load and torque ratings, stroke length and maximum cycle, size—also enters the calculations, as well as such special conditions as sand, viscous fluid, and corrosion. He can also recommend the best tubing string design, the prime mover, surface pumping unit, packer type and rod string.

When the installation is made, he will supervise it at no extra charge—set the pumps and packers, and be on hand for the initial pump running—to make sure you have an efficient, economical production setup.

Call in your Axelson specialist and let him work with you in engineering your multiple zone installations. If you are contemplating a multiple zone flowing well, the Axelson specialist can install the correct cross-over now—and you won't have to pull tubing when you run the two-zone pump later!

Write the Special Products Department, Axelson Div. of U. S. Industries, 6160 S. Boyle Ave., Los Angeles 58, Calif.

SPECIAL NOTICE

For deep and/or high volume two-zone production Axelson announces a new special two-zone pump to run under a 26-ft. hydraulic pumping unit. Write for more information on this type of installation.

Write, Today, for New Facts

Box B
Axelson Division
U. S. Industries, Inc.
6160 So. Boyle Ave.
Los Angeles 58, Calif.

- ☐ Two-Zone Pump
- ☐ High Volume Casing Pump
- ☐ Long Stroke 2-Zone Pump

NAME_____

COMPANY_____

ADDRESS_____

© 1960—U. S. Industries, Inc., Los Angeles, Calif.

New Equipment

Automatic Vent Valve

A corrosion-resistant automatic vent valve for water flood and salt water disposal wells has been developed by Kenneth N. Mills.

The valve is direct acting, with a non-crushable plastic float, synthetic rubber valves, and a clear plastic body.

When installed on a gravity input well, the valve will vent gas from the well, but it will not let air enter. Float-actuated valve prevents back-flow.

Clear plastic body permits visual inspection of working parts, all parts are corrosion resistant, and the body has a maximum resistance to accumulation of gyp, iron sulfide, and other material which could cause malfunctioning. *Kenneth N. Mills.*

Circle number (16) on reply card.

Diamond Drill Bits And Coring Service

A new, 20-page catalog describing the complete line of diamond drill bits, diamond core heads, core barrels, and contract coring services has been prepared by American Coldset.

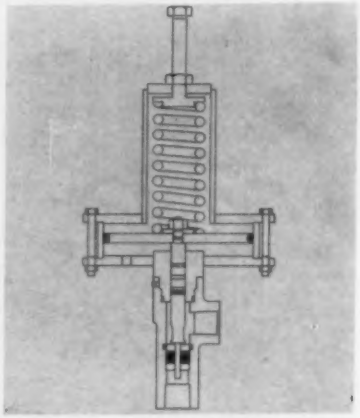
The firm's Hillmac Division serves the oil industry in the United States, its Canadian subsidiary, Core Well Ltd., serves the Canadian market.

Special features of this new product catalog include a comprehensive report on recent diamond drilling progress, as evidenced by actual field results, and a complete treatment of diamond product design principles as they apply to actual formations and hole conditions.

Included in the catalog are types of diamond drill bits, including custom designs; types of diamond core heads; price lists; engineering features of core barrels; contract coring services, including equipment rentals and engineering services; manufacturing, engineering and sales facilities; and service locations of the firm around the world. *American Coldset Corporation.*

Circle number (17) on reply card.

Dump Valve



A dump valve incorporating a piston motor to provide greater power in a more compact package has been introduced by APCO.

The check-stream is engineered to stop leakage by providing a more positive means of shut-off. A solid rubber cylinder, expanded against the body liner by the piston motor, provides leak-proof shut-off and eliminates the major cause of dump valve failures.

The piston is opposed by a spring, which closes the valve when the instrument output pressure is zero. The spring drives the valve shaft forward, and the shaft, which operates against the movable spider on the rubber cylinder, causes the spider to move forward. This expands the rubber cylinder against the body liner and effects a fluid-tight shut-off.

Another important feature is throttling action. Whenever the control instruments exert enough air pressure to balance the force of the spring, the piston moves upward. This allows the rubber cylinder to contract and liquid to flow between the cylinder and body liner. *APCO division of Textron, Inc.*

Circle number (18) on reply card.

Straightening Vane For Well Flow

A well-flow straightening vane designed to correct the turbulence of oil and gas before it enters the tubing has been developed by Petroleum Instrument.

By eliminating the vortex at the bottom of the tubing caused by the swirling action of the formation fluid or gas as it enters the production pipe through perforations, production may be substantially increased.

The vanes are offered in 2 models, both of which are provided with a 2⅜ in. API upset tubing thread for attaching to the bottom joint of tubing.

The standard packer type, for use with conventional production packers, is 4½ in. OD, full opening, and will pass any tools that will pass through the tubing strings.

The other model, which is 2½ in. OD, is for use with insert type packers. *Petroleum Instrument Company.*

Circle number (19) on reply card.

BOTH ZONES OF DUAL WELLS SUCCESSFULLY INTERMITTED WITH MERLA GAS LIFT VALVES!

The patented* Merla method of gas lifting dually completed wells uses a series of pressure operated valves in separate tubing strings to each zone.

Valves are set to operate so that fluid level in tubing determines the valve which the gas passes through. All valves are the same type, and operate from a common gas annulus and close at the same surface closing pressure.

Surface control of gas injection may be by fixed orifice, pressure regulator, time controlled valve or a combination of these methods.

*U.S. Patent No. 2642812

MERLA TOOL CORP.

manufacturers of oil tools and gas lift equipment

Contact your nearest Merla representative or
MERLA TOOL CORPORATION • P. O. BOX 2576
DALLAS 21, TEXAS

COMPLETED AS A PRODUCER . . .
BELOW 20,000 FEET

Had this well been dry, it would merely be another statistic. Yet, it was completed as a producer.

To prove production possibilities on this deep Louisiana well, five Drill Stem Tests were run below the 20,000 ft. mark. In each instance, the packers were set below 20,000 feet, making these the deepest Drill Stem Tests ever recorded.

Testing conditions were most severe. Throughout each test, bottom hole temperature was 426°, mud weight ranged from 18.2 to 18.4, with a viscosity varying from 50 to 60. During the five deep tests, Johnston equipment encountered and recorded formation pressures as high as 19,365 psi and hydrostatic mud pressures up to 22,045 psi.

Packers and other equipment have previously been run and set below this depth; however, none in a Drill Stem Testing operation, nor under the conditions encountered in this well.

No misruns or equipment failures occurred. All equipment was retrieved intact. On two tests, equipment remained in the hole over twenty hours. Tests were performed in 7 inch—35 lb. casing through a 3/8 inch bottom hole choke. All were successful.

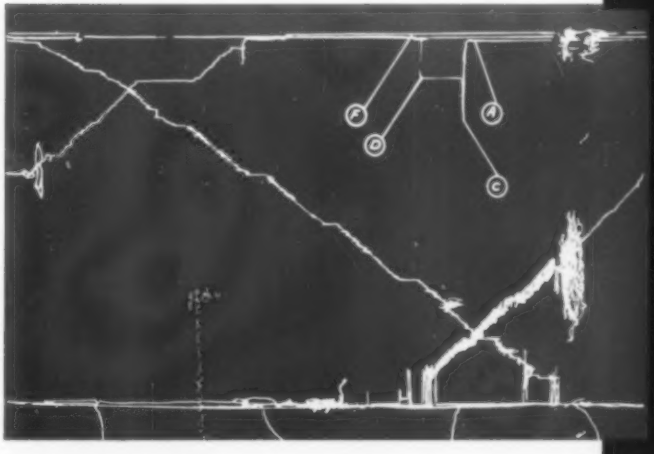
Drilling a well below 20,000 feet is a significant accomplishment, especially with the subsurface conditions peculiar to the Gulf Coast. The five Johnston Tests performed at this depth are also significant. They are testimony to the fact that Johnston can conduct Drill Stem Testing operations at extreme depths where high bottom-hole temperatures and extreme high pressures are encountered.

The drilling, testing and completion of this well is a prime example of the value of experience and planning, and proves the advisability of gathering all available information and data for evaluation prior to completing any well.

In any area . . . in any well . . . deep or shallow . . . high pressure or low pressure . . . before you set casing on your next well, call Johnston Testers. You get more from a Johnston test.

All tests were performed by Johnston Testers using the new Johnston testing tools.

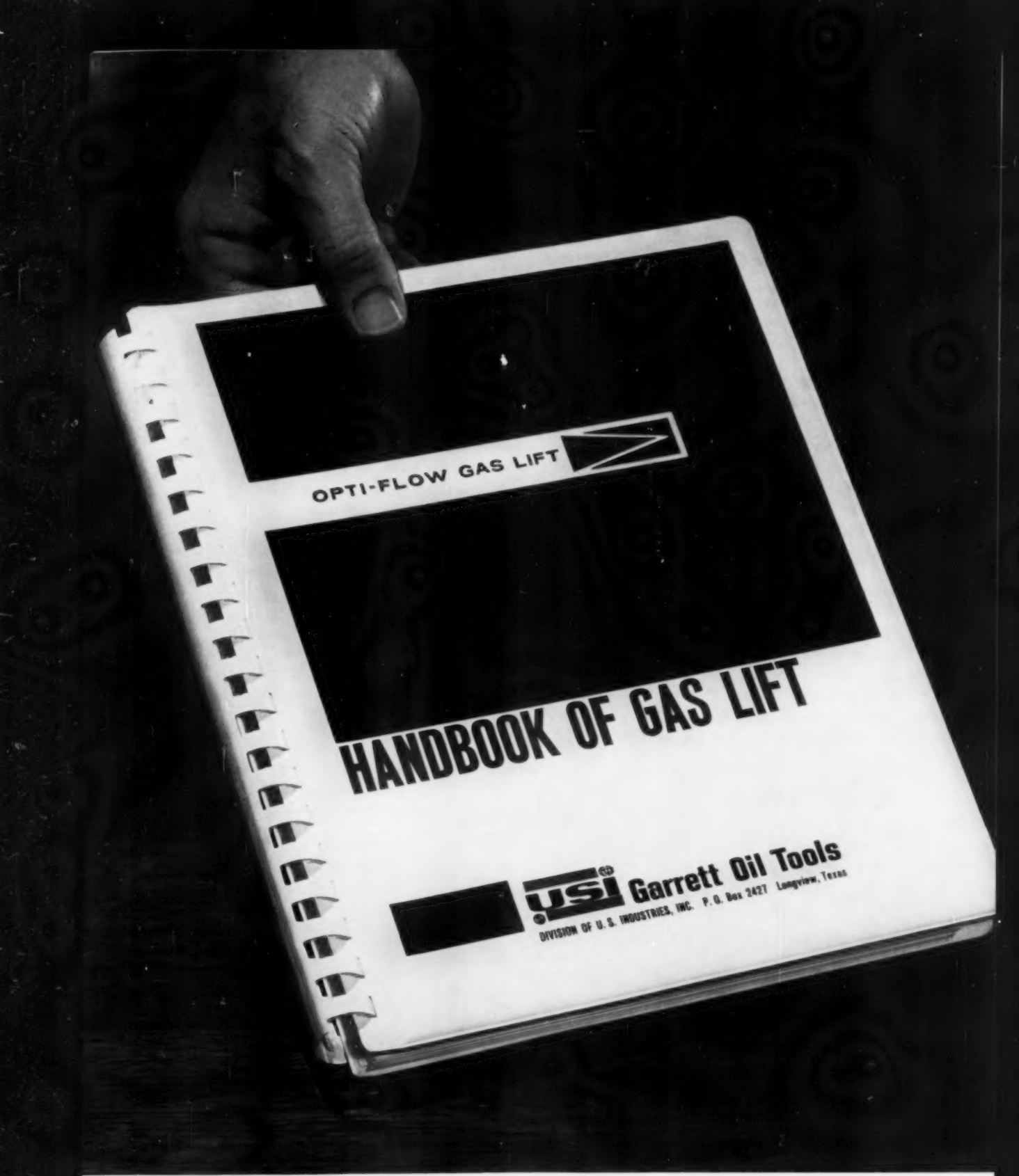
FINAL TEST
Packer set at 20,068'
Initial Hyd. Mud 19,960 psi
Initial Flow 15,435 psi
Final Flow 17,719 psi
Final Hyd. Mud 20,061 psi
Recovery Oil (39.5° Gravity) and Gas



JOHNSTON TESTERS, INC.

P. O. Box 98 Houston 1, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



For your copy of the Handbook of Gas Lift, please contact your nearest Garrett sales engineer.

Garrett Oil Tools

A DIVISION OF U. S. INDUSTRIES, INC.

PRESENTS

A COMPLETELY NEW CONCEPT OF GAS LIFT INSTALLATION DESIGN

From this Handbook of Gas Lift, these electronically computed master curves enable you to design your continuous lift wells for:

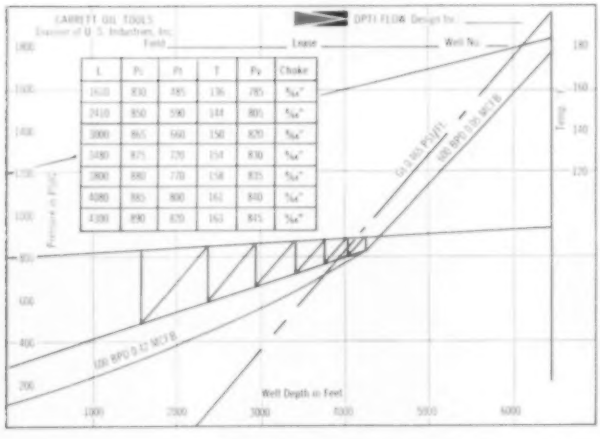
optimum flow with minimum compressor horsepower

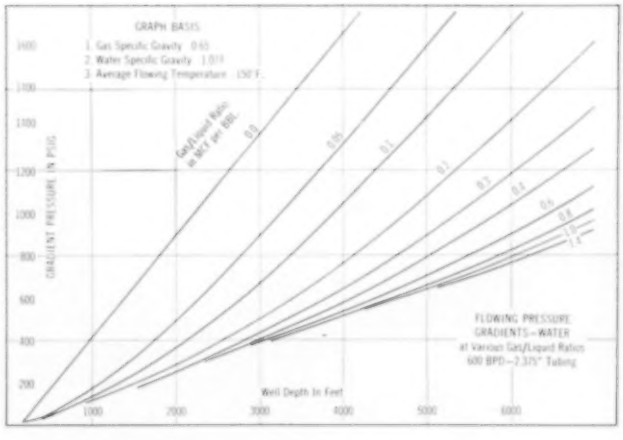
. . . or increased production with existing operating pressures

. . . or production at present flow rate with less compressor horsepower

. . . or production of additional wells with present compressor horsepower.

(Below) Advantages obtainable through the use of the Garrett *Opti-flow* technique are demonstrated by this gas lift design. (At right) The master curves used in solving this particular gas lift problem.





Garrett Oil Tools

Division of U. S. Industries, Inc. P. O. Box 2427, Longview, Texas

LARKIN

The preponderant use of Larkin Floating and Guiding Equipment is a natural result of its years of dependable performance. Experience brings confidence—and that's why thousands upon thousands of wells each year are safely and successfully cemented through Larkin Equipment. Available through your supply store.

LARKIN
...Through Your Supply Store

LARKIN PACKER COMPANY
DIVISION KOEHRING COMPANY
WAXAHACHIE, TEXAS

LARKIN LEADERSHIP HAS BEEN EARNED BY YEARS OF DEPENDABLE PERFORMANCE

DRILLING AND CEMENTING DATA

Job – J. T. Calliham #1, McMullen County, Texas

Service Contractor – Dowell Division of the Dow Chemical Company.

Job #1 – 9⅞" hole drilled to a depth of 12,290' below a 10¾" surface casing string set at 2,483'. 7" casing string run to 12,287' and cemented with 300 sacks of neat UNAFLO cement (slurry wt. 15½ lbs.) Mixing time 4 minutes. Pumping plug to bottom 42 minutes. Over-all mixing and pumping time 46 minutes. Drilling mud wt. 11.5 lbs/gal. Schlumberger recorded temp. 276° F. Estimated static BHT 320° F.

Job #2 – Baker D. V. Tool run in the 7" casing string at 5,770', and this section of pipe back to the surface cemented with 900 sacks UNAFLO cement plus 12% Gel. Slurry wt. 13 lbs/gal. Mixing time 35 minutes. Plug pumped down in 36 minutes. Total mixing and pumping time 71 minutes. Drilling mud wt. 11.5 lbs/gal. Est. static BHT 195° F. Temperature gradient for area 2° F. per 100' depths plus 80° F. mean temp.

At less than 6,000 feet – or at record depths

Oilmen rely on UNAFLO oil-well cement at all depths. In shallow depths, it gives good results, used neat or plus additives to lighten slurry weight when high fillups are desired.

Its slurries sustain high initial fluidity, and its retarded set allows proper placement with an added margin of safety for delays or emergencies.

For cementing or recementing, for plug-backs or squeezes, at varying depths, pressures, drilling conditions, UNAFLO cement provides the workable slurry – one that pumps easily, sets hard. For more data, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

"USS" and "Unaflo" are registered trademarks

Universal Atlas Cement
Division of
United States Steel

U-162

OFFICES: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco

Drilling-Praducing Literature

Diesel-Driven Generator Sets

Entire new line of diesel-engine-driven generating sets, recently announced by D. W. Onan & Sons, Inc., is described and illustrated in a 2-color folder recently issued.

These heavy-duty diesel sets provide a continuous source of electricity for oil field uses and microwave installations.

Specifications and illustrations of these sets, in sizes ranging from 3000 to 6000 w (air-cooled) and from 10,000 to 230,000 w (water-cooled) are included in the 4-page folder. Diesel-driven marine electric generating plants are described as well as a selection of accessories and controls. *D. W. Onan & Sons Inc.*

Circle number (21) on reply card.

Hand, Power Winches

A new catalog is available on Thern hand and power winches, both spur gear and worm gear models. Capacities range up to 5000 lb. *Thern Machine Company.*

Circle number (22) on reply card.

Gas Injection Project

Bulletin 183, just published by Clark Bros., presents a report on Arabian American Oil Company's new gas injection project in 'Ain Dar, Saudi Arabia. It describes the $30,000,000 project which will gather and inject 210,000,000 cu ft of gas per day in the Ghawar field.

All details of the operation are covered, including use of 5 series-connected gas turbines for compressor drive, plus the use of an additional turbine to drive a 5600 kw generator to power the gas-oil separator plants. *Clark Bros. Company.*

Circle number (23) on reply card.

V Molded Packings

Manual presents a comprehensive technical description of an advanced form of V-type molded packings, the Palmetto Pyramid. It consists of a series of 3 or more nested rings — a flat bottom adapter, a flat top adapter, and the required number of V sealing rings.

Two distinctive designs are described—shallow pyramid, used where space is limited; deep pyramid, used where stability and sturdiness are required. *Greene, Tweed & Co.*

Circle number (24) on reply card.

Valve Selection

A 4-page booklet describes the Circle Seal line of valves. It contains technical data, construction details, dimension, materials, operating principles, and how to order information. Check valves, relief valves, shutoff valves, plug valves, and custom valves are described. *Circle Seal Products Company, Inc.*

Circle number (25) on reply card.

Variable Speed Pulleys

A full line of variable speed pulleys — plus related equipment including compound drives, motor bases and frames, wide V-belts and sheaves — is described in a new 24-page illustrated technical catalog. Information includes selection and operating data, horsepower ratings, dimensions and representative applications for the wide variety of sizes and models.

The variable speed pulleys are the cam-operated type. They range from fractional to 5 hp with speed ratios between 1.75 to 1 and 2.6 to 1. Five wide V-belt pulley models with speed ratios of 3 to 1 and 2 high-ratio types providing ratios up to 7.2 to 1 are also included. *Lovejoy Flexible Coupling Company.*

Circle number (26) on reply card.

Electric Plants

A 12-page folder illustrating the complete line of standard Kohler electric plants is now available. Electric plants for stand-by or sole supply are available in sizes ranging from 500 to 100,000 w. *Kohler Company.*

Circle number (27) on reply card.

Control Switches

A 56-page catalog, No. 860, lists mercury-switch equipped controls for single-stage pressure, 2-stage pressure, differential pressure, single-stage temperature, 2-stage temperature, liquid level and mechanical movement. Also illustrated are transformer-relays and a complete line of hermetically-sealed mercury switches.

Description of each control, with accompanying description, specifications, and engineering data, can be easily located by a dual index in the catalog. *The Mercoid Corporation.*

Circle number (28) on reply card.

Adjustable Speed Drives

Extensive information on General Electric's new Kinatrol line of eddy current coupling adjustable speed drives for 5 to 100 hp is contained in a 2-color, 12-page bulletin, GEA-6885.

Publication contains information on the eddy current coupling operating principle, as well as data on torque capabilities, regulation and operation of the entire packaged drive, which includes the main drive unit, control enclosure, and the operator's control. *General Electric Company.*

Circle number (29) on reply card.

Safety Head Assemblies

Full dimensional data for safety head assemblies designed for use with Baker rupture discs are given in a 4-page catalog published by High Pressure Equipment.

In combination, the safety head assemblies and precious metal rupture discs provide instant automatic release of excess pressure to high pressure air lines. *High Pressure Equipment Company.*

Circle number (30) on reply card.

Leak Resistant Pump

Two-page Dynapump Bulletin 420-D gives features and specifications of low-cost, compact, leak-resistant pump for commercial and industrial applications. It is a bronze fitted seal-less centrifugal pump. *Dynapump Division.*

Circle number (31) on reply card.

Butterfly Valve

The Henry Pratt Company Bulletin 10JT is a new catalog which illustrates and describes the new Monoflange Mark II Rubber Seat Butterfly Valve.

The catalog has been designed to be a working tool for engineers and users of this type of equipment. Complete specifications, certified dimension drawings, water flow data, gas flow data, weights and freight rates, and prices are included. *Henry Pratt Company.*

Circle number (32) on reply card.

Special Rod Pumps

Harbison-Fischer has published an illustrated bulletin on their Texas Stripper and Corsicana Special rod pumps. The two pumps are specially designed to handle scale, paraffin, sand, and well trash.

The Texas Stripper is a special rod pump designed to prevent the pump from sanding up when the well is shut down. The Corsicana Special operates with 1-in. pipe or hollow sucker rods instead of conventional solid rods. The pump is equipped with stroke-through extensions on either end of the barrel tube to keep foreign matter from damaging the working surfaces of the parts. *Harbison-Fischer Manufacturing Company.*

Circle number (33) on reply card.

Macaroni Tubing

The macaroni tubing handbook with multiple completion data has been published by Vinson. It includes macaroni tubing dimensional data, external upset minimum properties and setting depths; and selection of a multiple completion hook-up. *Vinson Supply Company.*

Circle number (34) on reply card.

Outboard Propulsion And Steering Units

Two-page condensed catalog shows installations and features of Harbormaster Outboard Propulsion and Steering Units. They are a complete marine power and steering package. Catalog gives details, including comprehensive table of specifications on 17 models from 40 to 500 hp. *Murray & Tregurtha, Inc.*

Circle number (35) on reply card.

Multi-Shielded Motors

Sterling announces availability of 4-page Bulletin No. 196 on the newly developed Sterlicone multi-shielded drip-resistant motors which were recently introduced by the company.

The bulletin illustrates the 5 outstanding design features, and it explains in detail how these motors can replace totally enclosed motors in many applications where adverse conditions of moisture, humidity, dust, oil, and chemicals are encountered. *Sterling Electric Motors, Inc.*

Circle number (36) on reply card.

Free to Subscribers!

Don't forget to order your 1959 Annual Index.

Write The Petroleum Engineer, Box 1589 Dallas 21, Texas

MOST IMPORTANT ADVANCES IN PUMP DESIGN IN 30 YEARS!

WHELAND *PLANETARY* HP-16000 SLUSH PUMP

DUPLEX POWER SLUSH PUMP 7¾" x 16"
600 HP at 65 RPM

U. S. Patent 2,649,988 and 2,717,186. Other patents pending

NOW! **FOR THE FIRST TIME . . .**
these proven mechanical principles are applied to a slush pump!

- **PLANETARY GEAR SYSTEM**
  with gear cartridge assembled and inserted as a unit.
- **CROSSHEAD IS A PERFECT CIRCLE**
  thus stays perfectly aligned in every direction.
- **FLOATING INPUT SHAFT**
  with unique sheave mounting which lets shaft transmit torque load ONLY.

Three years in designing, developing and in final field testing are behind this newest, most advanced WHELAND 16" PUMP. A folder giving the highlights of this new pump is yours for the asking . . . or we can give you current locations so you can see it in operation. You can't afford to buy any pump in this size until you've seen this new Wheland pump!

WHELAND

ROTARY DRILLING MACHINERY

THE WHELAND COMPANY
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CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

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EXPORT DISTRIBUTORS: LUCEY EXPORT CORPORATION—233 Broadway, New York 7, New York—Broad Street House, London, E. C. 2, England.

What's doing in DRILLING

Wilkins Elected President Of Servicing Contractors

J. W. Wilkins of Andrews, Texas, was elected president of the Association of Oilwell Servicing Contractors at their annual national convention held in Dallas recently.

Wilkins succeeds J. C. Williams, Jr., of Springhill, Louisiana, who held the office of president for the well servicing group in 1959. Wilkins served as the association's first treasurer when it was founded in 1956 in Odessa, Texas, and he was the second vice president for 1959.

He is co-owner of two oil well servicing companies, the Permian Servicing Company, Inc., Levelland, Texas, and D&J Services, Inc., Andrews, Texas.

Other officers elected include Leo L. Kent, Eldorado, Kansas, first vice president; and T. J. Hollis, Lovington, New Mexico, treasurer.

18-Year-Old Drawworks Drilling Deep Test Well

An 18-year-old drawworks is being used by Sun Drilling Company to drill Lloyd No. 300, a deep test well on the Tidewater lease in the Ventura Avenue field, California.

Equipped with a new drive group and power plant, the drawworks has been giving good performance. It has a long record of wells drilled in the Newhall, Rosecrans, and other fields in the Los Angeles Basin.

Originally put in service in 1941 by Barnsdall Oil Company, in the Rancho San Francisco field, near Newhall, the drawworks is the first Type 125 produced by The National Supply Company, and includes a number of features that were considered new and daring at the time.

Most deep drilling was being done with steam rigs or with steam rigs converted for other forms of power. Both used positive jaw-type drum clutches and required much hard work from the crew. The rig was the first to use air-actuated disc-type friction clutches and was much easier to operate.

Photo Courtesy National Supply Company.

The drawworks provided 10 drum speeds, a phenomenal number for that time. The rig was originally powered by two 300 hp engines, but at present it uses three V-12 engines rated at 800 hp each.

It uses a three-section drive group with hydraulic couplings and dual 28-in. clutches. The drive group is of the basic three-shaft design, with the shafts set on 96 in. centers instead of the usual 84 in. spacing. This accommodates the extra width of the large engines.

Two slush pumps handle mud requirements for the rig.

When more horsepower is needed . . . . . .

Easy enough, you say, on most rigs. But how about a self propelled rig? The *Wilson Winchmobile*, with cross-mounted engine, or engines, is the answer. Compounded, the engines both drive the winch drums and the rear axles. For really deep wells, this is the answer.

New Ruling Requires Blowout Precautions

A new ruling requires a lessee to take all reasonable precautions to prevent any well from blowing open, and to take immediate steps and exercise due diligence to bring blowouts that do occur under control, the U.S. Geological Survey announced.

The ruling also provides that storm chokes and similar safety devices are to be installed in any flowing oil or gas well. But, upon a showing by the lessee, the USGS supervisor may waive this requirement, if it is demonstrated that a choke or other device is not needed to protect the well, or is likely to cause damage to or loss of the well.

Mexicans Advance Support to Monopoly

The Mexican government has advanced $144,000,000 to support the government oil monopoly, Pascual Gutierrez Roldan, Petroleos Mexicanos head, stated recently.

Most of the funds represented a subsidy, since Pemex was exempted from payment of income taxes.

Pemex will now make a $40,000,000 payment in 1960 because of tax money owed the government.

Seacat Offshore to Drill In Arabia for Japanese

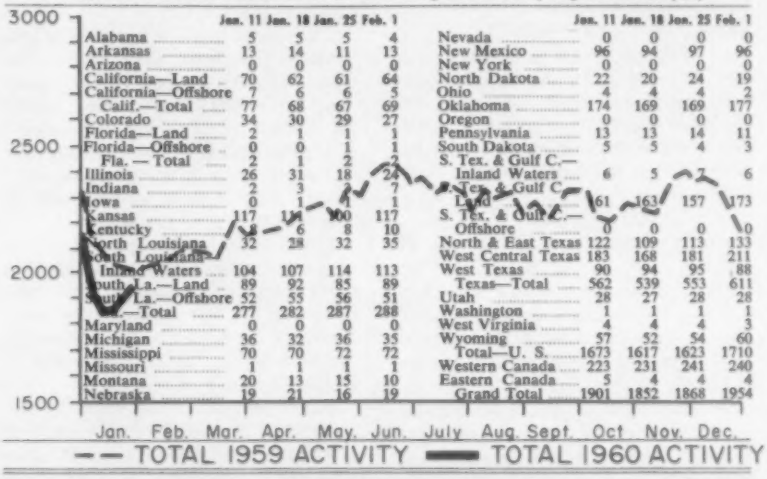
Seacat Offshore Drilling Co., S.A., has been awarded a two-year contract by Arabian Oil Co., Ltd., of Tokyo, Japan, for offshore drilling in the Persian Gulf adjacent to the neutral zone.

This work will be done by means of a drilling tender in conjunction with a rig on a fixed platform. The drilling tender is the SEDCO Rig 12, Barge 9, which has operated in the Gulf of Mexico during the past few years.

Seacat Offshore, affiliate of The Southeastern Drilling Corporation of Dallas, will furnish, in addition to the drilling tender and the platform type rig, a land camp which will be stationed in the neutral zone, and the necessary automotive equipment. Spudding of the first well should be accomplished by late May.

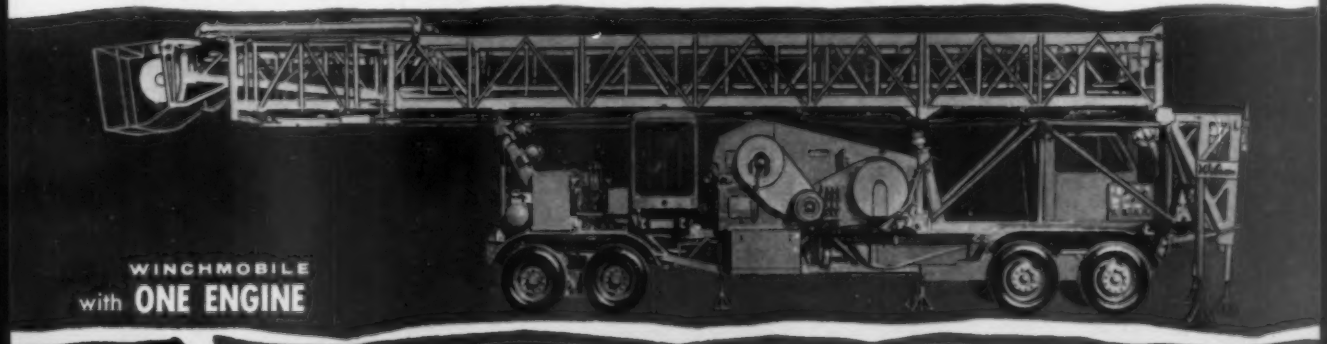
Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company



	Jan. 11	Jan. 18	Jan. 25	Feb. 1
Alabama	5	5	5	4
Arkansas	13	14	11	13
Arizona	0	0	0	0
California—Land	70	62	61	64
California—Offshore	7	6	6	5
Calif.—Total	77	68	67	69
Colorado	34	30	29	27
Florida—Land	2	1	1	1
Florida—Offshore	0	0	1	1
Fla. — Total	2	1	2	2
Illinois	26	31	18	24
Indiana	2	3	6	7
Iowa	0	1	1	1
Kansas	117	121	100	117
Kentucky	8	6	8	10
North Louisiana	32	28	32	35
South Louisiana				
Inland Waters	104	107	114	113
South La.—Land	89	92	85	89
South La.—Offshore	52	55	56	51
La.—Total	277	282	287	288
Maryland	0	0	0	0
Michigan	36	32	36	35
Mississippi	70	70	72	72
Missouri	1	1	1	1
Montana	20	13	15	10
Nebraska	19	21	16	19

	Jan. 11	Jan. 18	Jan. 25	Feb. 1
Nevada	0	0	0	0
New Mexico	96	94	97	96
New York	0	0	0	0
North Dakota	22	20	24	19
Ohio	4	4	4	2
Oklahoma	174	169	169	177
Oregon	0	0	0	0
Pennsylvania	13	13	14	11
South Dakota	5	5	4	3
S. Tex. & Gulf C.—				
Inland Waters	6	5	7	6
S. Tex. & Gulf C.—				
Land	161	163	157	173
S. Tex. & Gulf C.—				
Offshore	0	0	0	0
North & East Texas	122	109	113	133
West Central Texas	183	168	181	211
West Texas	90	94	95	88
Texas—Total	562	539	553	611
Utah	28	27	28	28
Washington	1	1	1	1
West Virginia	4	4	4	3
Wyoming	57	52	54	60
Total—U. S.	1673	1617	1623	1710
Western Canada	223	231	241	240
Eastern Canada	5	4	4	4
Grand Total	1901	1852	1868	1954



. . . . add another engine!

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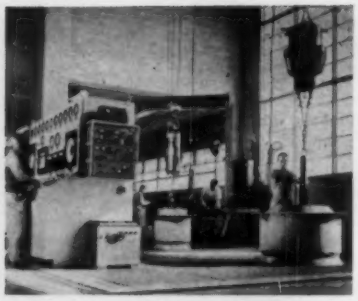


Photo Courtesy of Schlumberger Well Surveying Corp.

Test Chamber Trys Tools for Deep Wells

A new high pressure, high temperature chamber for testing sidewall sampling tools has been developed by Schlumberger Well Surveying Corporation to simulate bottomhole conditions equal to those in the deepest wells being drilled today.

The 78,000 lb pressure vessel has a working pressure of 30,000 psi at 450 F.

Its 12 in. inside diameter and 25 ft working length can accommodate the largest sampling tools or the targets used for testing perforating or sampling guns.

As many as 13 electrical connections can be made to the tool in the chamber through insulated conductors installed in the head.

The huge vessel is heated by circulating super-heated steam through grooves running between inner and outer shells of the chamber walls. The extremely high pressures are obtained by air-driven, plunger-type pumps. The pumps, steam generator, cooling mechanism, dump valves, and other components — all located in a pit below the steel flooring — are operated from a console panel.

The system includes many safety devices, which are connected into the control panel to give both audio and visual alarms should any part of the equipment misfunction.

An earlier chamber, built in 1942 with a rating of 10,000 psi at 300 F, is shown in the background of the picture and is still used in routine testing.

Another laboratory, completed in 1955, is equipped with two chambers of 20,000 and 25,000 psi working pressure. However, pressure and temperature requirements have advanced so rapidly that this laboratory, at completion, could not meet maximums expected to be encountered in new record-depth wells.

The pressure-temperature rating of the new pressure vessel is a maximum, Schlumberger engineers say, that can be produced with available materials. The laboratory can simulate greater downhole temperatures and pressure than any encountered today.

The widely-discussed drilling of a 50,000 ft well calls for much further progress in many technological fields. When this goal is attempted, Schlumberger engineers are confident that their new vessel can be adapted to simulate the bottomhole conditions expected.

AAODC Committee Discusses Drilling Practice

The annual mid-winter planning conference of the AAODC Committee on Education and Training was held in Dallas January 21-22.

Reports on projects under way and recently completed were given. Discussed were the course on drilling practices for drillers and drilling crews; the School of Drilling Technology, which was held in Odessa; and a review of the first term of the advanced engineering short course which ended at Texas A&M College January 15.

Other topics were a general review of developments in the field of drilling publications and training films, and plans for the advanced drilling engineering short course to be held during the present year at the University of Oklahoma at Norman.

Frank Whitley is chairman of the committee, and other officers are Jack Harrigan and George Walter, vice chairmen.

Offshore Drilling Platform Being Built in California

A second drilling platform at a state offshore lease near Summerland, California, is being erected on-site by Yuba Consolidated Industries of San Francisco for Standard Oil Company of California, Western Operations, Inc.

Cost of the work was placed at about $750,000.

The platform is currently under construction in Southern California and will be towed to the site in May of this year with start of drilling scheduled for late summer.

When installed, the second platform will stand in water 106 ft deep approximately 1¾ miles from the existing Summerland No. 1 platform. The completed installation will cost about $3,000,000 and will have facilities for drilling 24 wells, two at a time if desired.

Large Mobile Rig Drilling in Saudi Arabia

One of the largest completely mobile drilling rigs is being used by the Arabian American Oil Company in Saudi Arabia.

Consisting of a drawworks with three engines, a 100-ft telescopic mast, and other equipment mounted on a double-deck semi-trailer, the rig weighs more than 160,000 lb. Folded for transportation, it is 23 ft 6 in. high, 71 ft 6 in. long, and 28 ft 10 in. wide.

When rigged up for operation, with the mast erected, the rig is 117 ft high, 55 ft 6 in. long, and 44 ft wide.

Specially designed for desert drilling, the rig was placed in operation in June 1958 in the Rbu' al-Khali region, known as the Empty Quarter. Since that time, it has drilled three exploratory holes, ranging from 5000 to 7000 ft deep, and recently completed a 200-mile move to a fourth location.

This last move, through trackless desert, and over and around mountainous sand dunes, was accomplished in better than expected time.

A heavy truck hauls the trailer, and when sand conditions are very bad, tractor vehicles provide additional pulling power.

The drawworks is mounted on the top deck of the semi-trailer, with the working platform 12 ft above ground level. It is powered from a lower level by three engines with torque converters which deliver a total of 636 hp.

The mast has an API rating of 375,000 lb. Racking platform has a capacity of 9240 ft of 4½ in. drill pipe, although 3½ in. and smaller pipe actually is used.

A double helical reduction gear from the Number 3 drawworks engine is connected to a side outlet propeller shaft. This provides emergency power, when necessary, to a separate trailer on which two slush pumps and independent drives are assembled. Another trailer carries the drill pipe and collars.

The semi-trailer is supported on two sets of dollies and uses a total of eight desert tires, each 21 by 25 in. The tandem load on the dollies is 123,300 lb, excluding their own weight, and the kingpin load on the truck is 37,760 lb.

For a number of years, Arabian American operated smaller rigs for exploratory drilling in the vast desert area that constitutes its concession in Saudi Arabia. This experience showed the need for larger equipment, with greater depth capacity, but which would be completely mobile and suitable for transport over sandy, hilly, desert terrain.

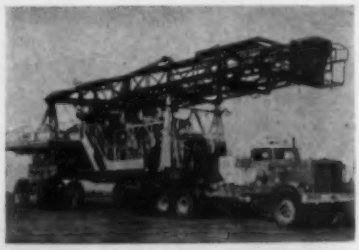
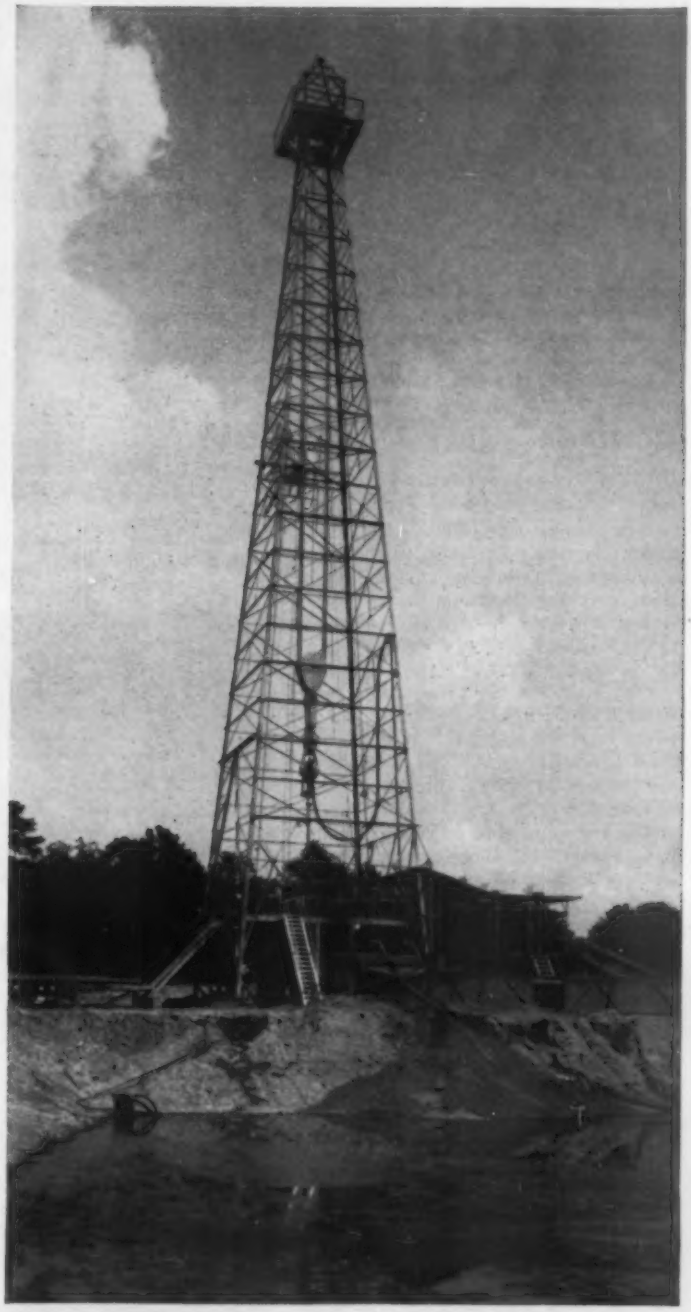


Photo Courtesy Arabian American Oil Company.

Big drilling news from Gardner-Denver

- Drawworks
- Crown blocks
- Traveling blocks
- Swivels
- Rotary tables
- Compounds
- Air compressors
- Mud pumps
- Air hoists
- Water pumps
- Centrifugal pumps
- Impact wrenches



Gardner-Denver is keeping pace with oil industry progress in the development of equipment today for the challenge of tomorrow. Ask your Gardner-Denver petroleum industry specialist about these great new products for deepest drilling.

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

EXPLORATION ACTIVITIES

NIGERIA

Five Exploration Wells Spudded, Three Strikes

Five exploration wells have been spudded in recently, and three completed in Nigeria by The Shell-BP Petroleum Development Company of Nigeria Ltd., Lagos. Two of the completed wells were successful, and one was a dry hole.

Completed wells were Ibibio 1, UYO Province, which reached a depth of 9179 ft; and Alakiri, Degema Province, which reached a depth of 11,490 ft.

The dry hole, Umuowa 1 in Owerri Province, reached 6803 ft.

MONTANA

Drilling Program Planned Near Glacier National Park

Negotiations for drilling east of Glacier National Park and southwest of Browning, Montana in the area known as the Mountain Front-Disturbed Belt have been completed by Great Northern Drilling Company and Union Oil Company of California.

First well will be drilled near the foothills of the Rockies of Glacier National Park, just east a few miles from the Continental Divide and south of the Alberta-Montana international boundary.

The first well will be commenced before June 30, 1960 about 45 miles west of the Cut Bank oil and gas fields.

Natural gas and light condensate oils were found previously in the former Union Oil Company-Morning Gun well, which was drilled in 1955 to an approximate depth of 9600 ft, in the top of the Madison lime.

This well tested initially approximately 6 million cu ft of natural gas per day and 54 bbl of high gravity oil.

LIBYA

Esso Sirte Acquires Interest in Concessions

Esso Sirte, Inc. has acquired from Libyan American Oil Company and W. R. Grace and Company, an undivided half interest in concessions 16, 17, and 20 in Cyrenaica and Tripolitania provinces of Libya. The transaction was approved by the Libyan Government.

Esso Sirte will be the operator of the concessions, which include two completed wells capable of producing about 2000 bbl daily in concession 17 in Tripolitania province. Oil has also been found in a third well in the same concession, and it is now being completed.

KANSAS

Remote Wildcat Well Strikes in Western Kansas

A remote wildcat discovery for western Kansas is 1-16 Tate "A" in NW SE 16-24s-41w, Hamilton County.

The Chase Permian discovery, 15 miles west of Hugoton field proper, flowed 741 Mcfd on 5/64-in. choke from perforations at 2305-11 and 2315-20 ft. Location is five miles southwest of Syracuse, eight miles northeast of Helfrick Morrow field and eight miles from new Gould Morrow oil field.

COLORADO

First Well Completed In Extensive Program

The first well in an extensive drilling program planned in the western Nebraska and eastern Colorado sectors of the Denver-Julesburg Basin has been completed, Falcon Seaboard Drilling Company of Tulsa and associates announced recently.

The well No. 1 Singleton Heirs, NE NW 29-17n-53w, in the Singleton field of Banner County, was pumping 200 bbl of oil a day after recovering load from fractured perforations in the J-A3 sand, perforated at 5531-35 ft. Total depth is 6440 ft, with casing run to 5613.

A number of wells are planned by Falcon Seaboard and associates during the next 15 to 16 months, company officials stated. Indications are that between 20 and 40 wells will be drilled.

Falcon Seaboard will be operator of the wells.

In a departure from its normal operations, the company will probably contract most of the drilling to other firms in the Denver-Julesburg area since none of its rigs are there.

A significant gas-discovery well at Lookout Butte, seven miles southwest of the Pincher Creek gas field in Alberta, has an indicated open flow potential of 31 million cu ft of gas per day. Drilled to a depth of 12,648 ft, the British-American Petroleum Company well flowed at sustained rates as high as 22.4 million cu ft of gas per day during productivity tests from the Rundle formation, where a gross pay thickness of 658 ft was encountered. With each million cu ft of gas the well prdouces 94 bbl of condensate.

PATENTS APPLIED FOR

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Exploration

TEXAS

Multiple Zone Wildcat Completed Near Yorktown

A multiple-zone wildcat well has been completed by the Lion Oil Company division of Monsanto Chemical Company near Yorktown in DeWitt County, Texas.

The Belitz No. 1 was drilled to a total depth of 10,517 ft and encountered about 136 ft of possible gas condensate sand in five pay zones of the Lower Wilcox formation between 9720 and 10,000 ft.

Completed as a dual gas-condensate well from perforations at 9840 to 9870 ft and 9716 to 9734 ft, the lower zone produced three million cu ft of gas and 75 bbl of condensate per day on a ⅜-in. choke. The upper zone produced 2.2 million cu ft of gas and 60 bbl of condensate per day on a ¼-in. choke.

The discovery was drilled on a unit block jointly owned by Monsanto and Humble Oil and Refining Company. The companies plan to start a confirmation well immediately.

Deep Wildcat Strikes In Oilman's Duck Pond

A wildcat which caused David C. Bintliff, Houston oil operator and financier, to miss a season's duck shooting on a 110-acre lake in his 4500-acre Bar X ranch in Brazoria County, South Texas, paid him for his trouble.

Located in the middle of the lake and ¾ mile from nearest production, the 15,730-ft Bintliff No. 1 is owned by San Jacinto Oil & Gas Company and Bintliff.

The well potentialed 1.5 million cu ft of gas plus an estimated 20 bbl per day of distillate from perforations at 10,848-58.

Two high pressure gas sands were left untapped behind the casing downhole.

Canyon Reef Discovery Hits 35 ft Pay Zone

Successful completion of Canyon Reef discovery well in Jones County, Texas by Texam Oil Corporation was announced recently.

Approximately 35 ft of productive reef section, containing 20 ft of continuous porosity, was encountered in the top of the reef from 4596 to 4616 ft. Oil-water contact has been established at 4635 ft.

In an official potential test, the well flowed 204 bbl of 40 deg gravity oil in 24 hr through a ¼-in. choke, from perforations between 4596 and 4606 ft. Flowing pressure averaged 525 psi.

Significant Gas Discovered In Previously Dry County

A significant new gas field discovery has been made in previously dry Denton County, Texas, by Bayview Oil Corporation and Carter-Gifford Oil Company, both Dallas companies.

The discovery, in a new and previously unknown productive zone, brings to light what appears to be a vast unexplored area of gas producing possibilities.

The No. 1 W. T. Evers, located approximately three miles east of Denton, Texas in the M. E. Forrest Survey A-417, was completed for an absolute open flow potential of 5,400,000 cu ft of dry gas per day from the Cordell sand of Pennsylvanian Age through perforations at 3663-73 ft and 3680-86 ft.

The new discovery was bottomed at 3889 ft with 4.5-in. casing being set at 3849 ft. The top of the Cordell sand is 3659 ft. Flowing tubing pressure on 14/64-in. choke is 1075 psia; shut-in tubing pressure is 1520 psia; calculated bottom-hole pressure is 1730 psia.

Additional pay is indicated up the hole in the Caddo; on drillstem test from 2914-24 ft, gas surfaced in three minutes at a one hour and ten minute test; initial flow was 40 lb, final flow was 80 lb, and 30-min shut-in bottom-hole pressure was 1120 lb.

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OIL FIELD TYPE

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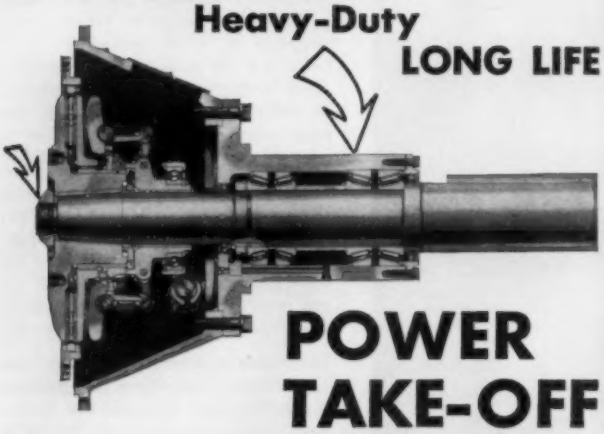

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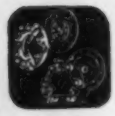
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CLUTCHES

B-126

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TRINIDAD

Offshore Exploration Began on 5700-Acre License

An offshore exploratory drilling program is being inaugurated on the 5700-acre marine license off the west coast of Trinidad which is owned by Kern Trinidad Oil Fields, Ltd., and in which Christiana Oil Corporation has a 15 percent net profit interest. Kern Trinidad is a subsidiary of Rio Tinto Company, Ltd.

Another company is expanding its operations in Trinidad as a result of encouragement from its discovery well in the East San Francique area recently. Panoil Company of Dallas is increasing its drilling program and adding a waterflood project.

Panoil has been operating in Trinidad since June under a management contract with Premier Consolidated Oil Fields, Ltd., of London. Sam DeWitt, Dallas petroleum engineer, is manager of technical operations.

The East San Francique No. 4, completed at 800-830 ft, flowed 250 bbl of 23-gravity oil in 15 hours through 12/32-in. bean, with tubing pressure of 150 lb and casing pressure of 310 lb. The well discovered three other shallow sands, which haven't been tested yet.

Twelve additional locations have been made for drilling early in 1960.

The deepest well drilled in Texas outside of the far-western area of the state, Carroll I wildcat, in DeWitt County, has been drilled to 19,765 ft. Drilled for Shell Oil Company by Meadows and Walker Drilling Company of Houston, the well has been plugged back and preparations are now underway for testing upper zones.

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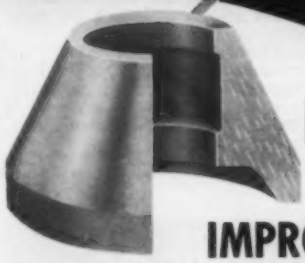
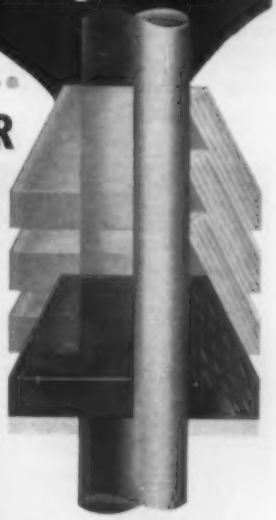


NOW... ANOTHER IMPROVEMENT



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SUPPLIERS' PARADE

Pan Geo Atlas Corporation has purchased the entire acoustic logging division of Empire Geophysical, Inc., of Fort Worth. PGAC has taken over all operating equipment and tools, the entire personnel, and the branch offices and stations of the division, operated from district headquarters at Odessa and Corpus Christi, Texas, and at Jackson, Mississippi.

Charles H. Thurber, formerly vice president of Empire and general manager of the acoustic logging division, will continue as manager of the acoustic logging department.

R. E. Stewart, district engineer in charge of acoustic logging in the West Texas district, will continue in the same capacity, with headquarters at Odessa.

B. J. Gay, district engineer in charge of acoustic logging in the South Texas district, will hold the same position, with headquarters at Corpus Christi.

D. M. Muir, district engineer in charge of acoustic logging for the Mississippi district, will also continue on the same assignment.

Drilltrol Company. Norman Jaques, vice president and sales manager of the Drilltrol Company of Long Beach, California, recently completed an extended tour of the oilfields in Trinidad, Venezuela, Colombia, and Mexico.

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OSR-12

Orbit Valve Company. Ed B. Lockey has been appointed as a sales representative and will represent the Tulsa valve manufacturer in North Louisiana, Mississippi and South Arkansas.

E. B. Lockey

S. R. Hill

W. C. Norris, Mfr. Stanley R. Hill has joined the sales force of the division of Dover Products of Canada, Ltd. He has been assigned to the company's Canadian sales division at Edmonton, Alberta, and will headquarter in Calgary, Alberta.

Welex, Inc. Jack B. Vaughan, former sales vice president for Welex, wireline service company, announced his resignation recently to enter private business.

Vaughan, a veteran of 25 years in the oil well service industry, also resigned as a Welex director, director of Welex of Canada, Ltd., and director of Jet Research Center, Inc.

A. F. Sheller

Waukesha Motor Company. A. Foster Sheller has been named manufacturing manager. In his new position, he will supervise and coordinate activities of the departments within the organization directly concerned with, or closely related to, the manufacturing process. These include purchasing, tool design, plant engineering, personnel, inspection, production, manufacturing, rate and time study, and the Climax plant at Clinton, Iowa.

Detroit Controls, division of American-Standard has elevated three top executives to vice president.

The three included John R. Warnock, general manager of marketing; Richard L. Campbell, director of engineering; and George F. Butterfield, general manager of manufacturing. They will continue to supervise these activities.

Dowell. Joseph P. Moran has been made manager of technical services and development department in Tulsa. He replaces J. A. Harmon, who is now district manager for the company in Amarillo.

J. P. Moran

M. L. Talbert

Security Engineering. M. L. Talbert has been named vice president-engineering of Security Engineering division, one of the Dresser Industries.

Symington Wayne Corporation and their Wayne Pump Company division have appointed Gray & Rogers, Philadelphia advertising and public relations agency, to create and direct programs of advertising and public relations.

Ingersoll-Rand Company has elected W. T. Alderson vice president. Alderson, previously manager of the company's compressor engineering department, will be located in the company's New York executive offices.

W. T. Alderson

Weldon Martin

Weatherford Oil Tool Company. Weldon Martin of Houston has been named vice president and will direct the revamping of the company's organizational chart.

Nine vice presidents have been appointed.

Heading the operations in the Eastern Hemisphere are Thomas E. Remp, Jr. of Hannover, West Germany, vice president distribution (foreign); and Addison Love, vice president, chief engineer, and works manager (foreign).

F. H. Drury with Weatherford Oil Tool Co., Ltd., Edmonton, Alberta, Canada, was appointed vice president at large. Also appointed vice president at large is R. H. Hume, president of Fabrimex S. A. de C. V., Mexico City, a subsidiary company.

James C. Niver of Houston is now vice president of finance. Walter Carter of Weatherford, Texas, is vice president of the ranch division.

To continue as vice presidents are: Fredda Dood of Houston, vice president chief accountant; Ben Owens of Weatherford, Texas, vice president works manager (domestic); and Homer Longino of Houston, vice president distribution (domestic).

Tyson Smith Company. Donald (Don) Fisher and Sonny McCurry have been added to the sales engineering staff of Tyson Smith.

As sales engineers, Fisher and McCurry will work with sales and service of the firm's oil and gas process equipment in the Houston area.

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Suppliers' Parade

Cameron Iron Works, Inc. The pressure control equipment division has appointed G. E. Nevill engineer of standards in the product engineering department.

This function will include active representation of the company on technical committees and assisting in the preparation or review of technical papers and releases, and assisting in patent matters.

G. E. Nevill

W. F. Krause Jr.

Baash-Ross. William F. Krause Jr. has been transferred to the Harvey, Louisiana, office of the Baash-Ross division of Joy Manufacturing Company. Krause will serve as Gulf Coast area sales engineer in Harvey.

Hughes Tool Company. Paul Reeve, manager of the engineering administration department of Hughes, has received a certificate of award from the petroleum division executive committee of the American Society of Mechanical Engineers. The award was made in recognition of his work as chairman of the division conference arrangements committee for the group's annual session which was held in Houston in October.

ACF Industries, Inc. Russell C. Taylor has been elected president, and James F. Clark chairman, of the executive committee of ACF.

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KLAMPON CORPORATION

Seismograph Service Corporation. New assignments for three key personnel in well logging division have been announced.

Lloyd C. Fons, former Midwest area manager for the Birdwell division in Robinson, Illinois, has been named sales manager for Birdwell with headquarters in Tulsa. William Sturdevant, former Oklahoma area manager in Tulsa, will be Midwest area manager in Robinson, succeeding Fons.

Joseph Ferguson, who has been area manager for continuous velocity logging operations, will become Mid-Continent area manager for Birdwell.

L. C. Fons

Wm. Sturdevant

The Western Company. Cyrus V. Helm has been named administrative assistant to Walter Beadle, executive vice president of The Western Company, oil well servicing concern with general offices at Fort Worth. Helm will be responsible for evaluating and formalizing the company's planning functions, as well as coordinating the administrative functions of Beadle's department.

C. V. Helm

J. W. Anthony

Corrosion Rectifying Company. John W. Anthony has recently established offices in Dallas as North Texas division manager for Corrosion Rectifying. He will specialize in corrosion problems related to cathodic protection, downhole well corrosion, surface equipment, and problems associated with waterflooding.

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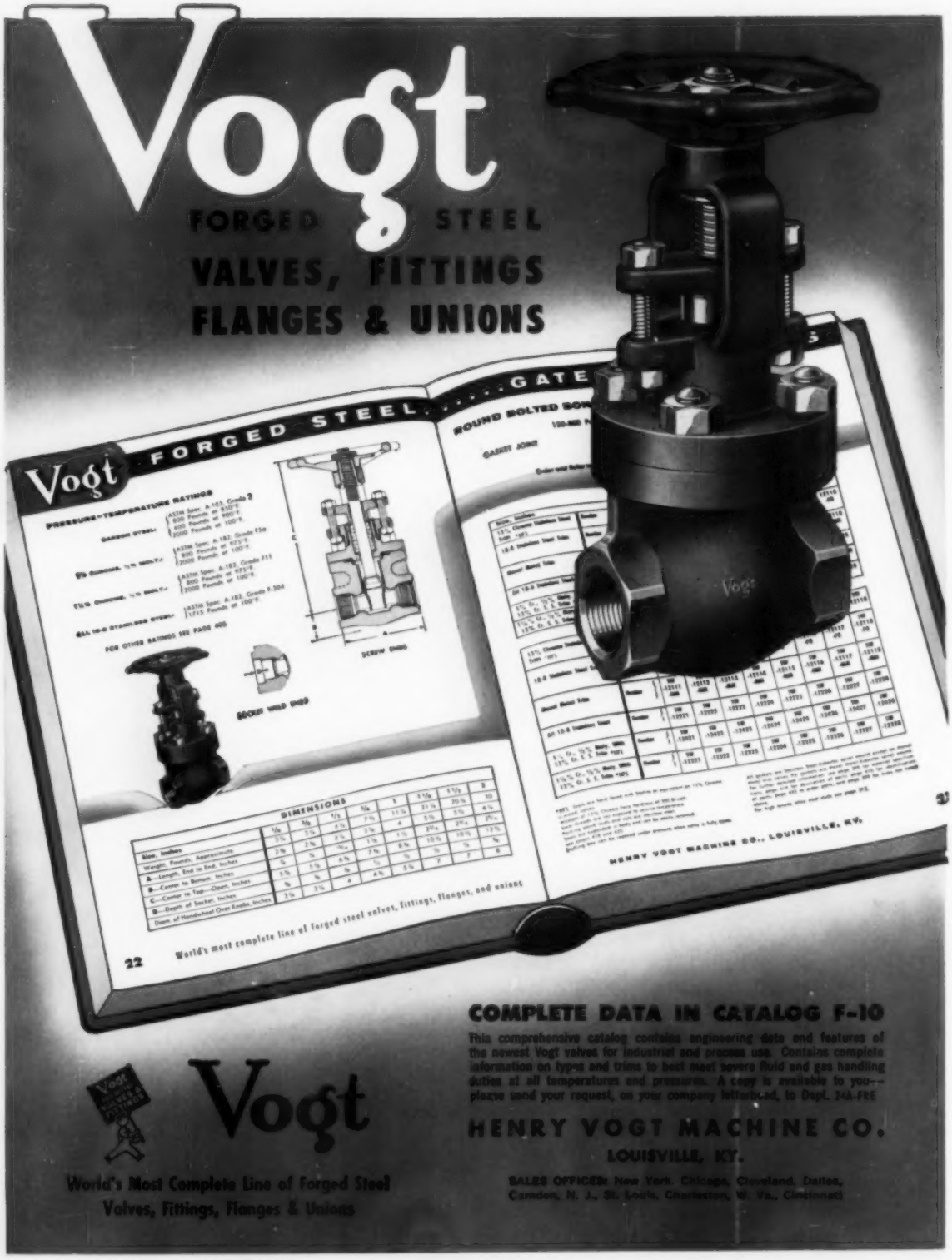
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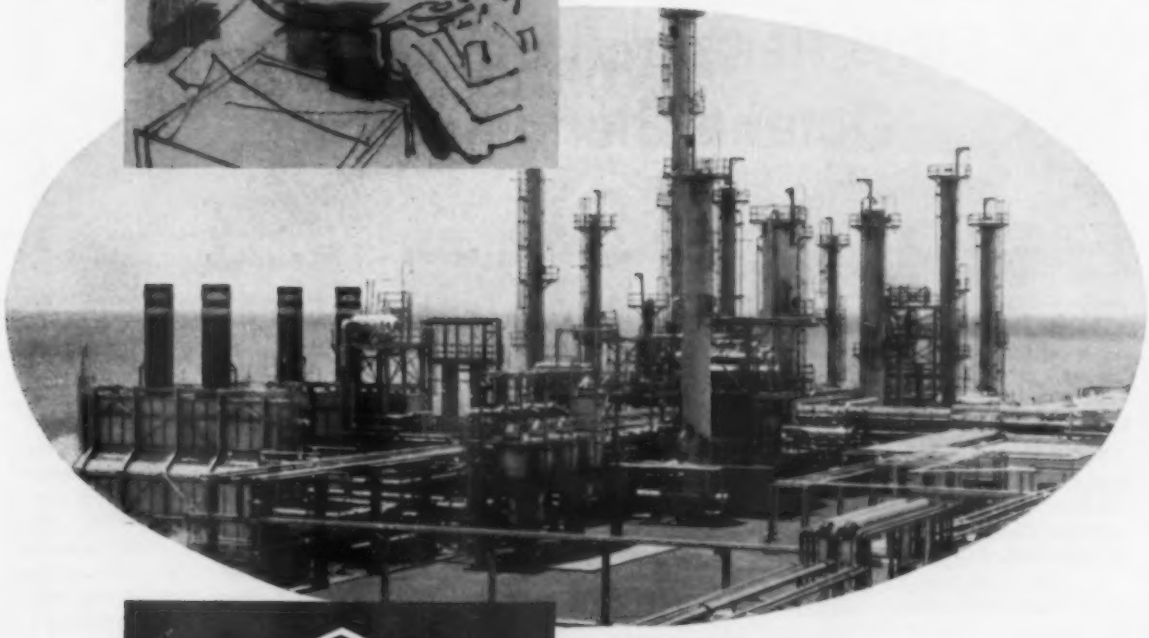

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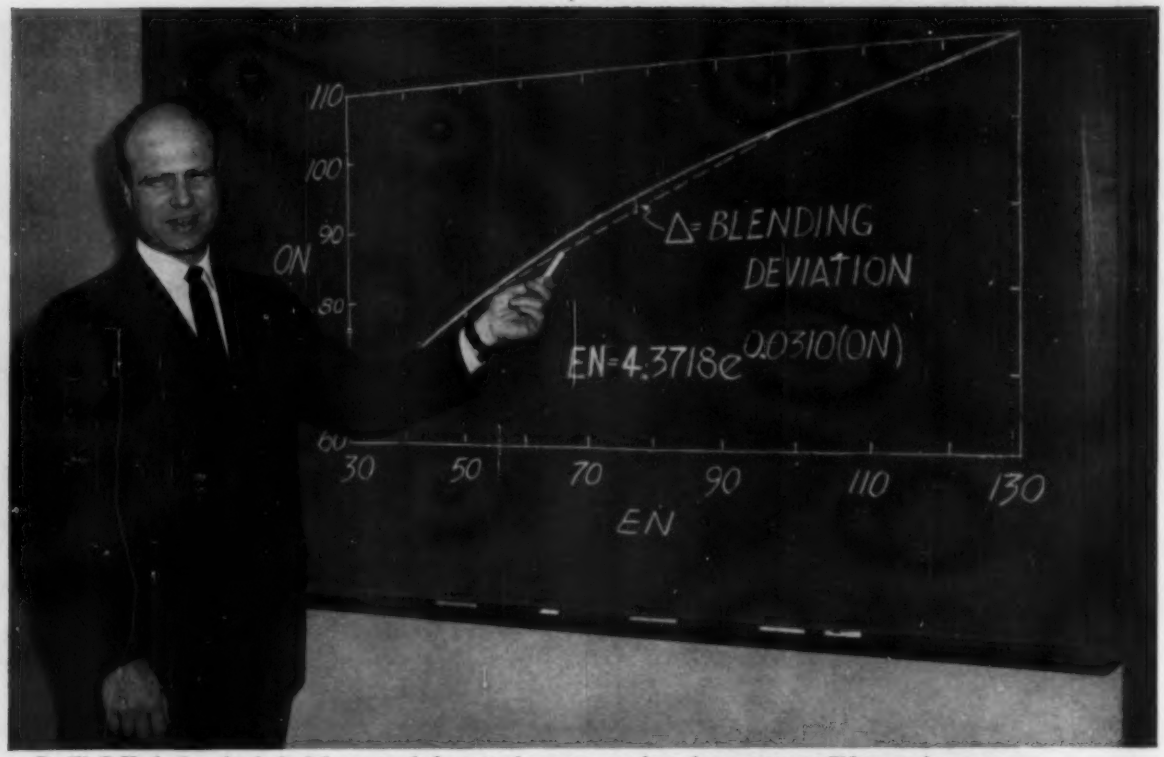

Dr. W. C. Healy, Jr., who devised the new scale for averaging octane numbers, demonstrates an EN conversion curve.

Ethyl Research develops new Octane Blending Scale

FOR MANY YEARS, refiners have been plagued by the fact that octane numbers do not blend by volume. The volumetric average of component octane numbers is usually higher or lower than the octane number of the corresponding blend of the components. This is commonly referred to as a blending bonus (or deficit).

Numerous schemes have been developed to calculate octane quality of finished blends. Unfortunately, few methods have universal application or a simple mathematical approach to solution.

A further disadvantage exists since many of the current blending computation schemes are basically non-linear, and thus have only indirect application in linear programming problems.

New Scale Based on Exponential Function

It has been observed in a review of countless gasoline blending studies that blending bonus (or deficit) tends to vary with the octane differences of the components. To be more specific, in multi-component refinery blends, the blending bonus is often almost proportional to the average squared octane difference between components. As a result of the discovery of this relationship, the EN scale was developed.

The scale has the following form:

$$EN = a + be^{2k(ON)}$$

where:

EN = converted octane number

a = arbitrary constant

b = arbitrary constant

e = natural logarithm base

k = exponential constant determined for each refinery application.

ON = octane number.

A curve showing this relationship for a specific refinery is demonstrated in the illustration above.

How to Determine the Exponential Constant "k"

The exponential constant k may be determined very simply for a particular refinery from a group of typical gasoline blends. *Blending deviation* (observed blend octane number minus volumetric average of component octane numbers) plotted versus the *volumetric average of the squared component octane numbers minus the square of the volumetric-average octane number* $\left[\overline{ON^2} - (\overline{ON})^2\right]$. The numerical value of k is the slope of a line through the plotted points and the origin. In order that different TEL levels be represented in determining k, the plot should encompass a range—say 0.5 and 3.0 ml/gal.

To completely define the new blending scale, values must be assigned to "a" and "b". The choice is completely arbitrary and is governed by convenience. For example, values may be chosen

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so EN is equal to 100 when ON equals 100; or the EN scale may be made to match the ON scale at two points, for example 80 and 100. It is usual for b to have the same sign as k so that ENs increase when ONs increase.

How Accurate is the Scale?

In order to check the accuracy of the scale and illustrate its efficiency, standard errors are compared for four systems of determining final blend octanes.

1. Volumetric average of *component ONs.*
2. *Octane blending values* by least squares method and volumetric average of values so determined.
3. Volumetric average of *component ENs* and conversion of this average to ON.
4. *EN blending values* by least squares method, volumetric average of values so determined, and conversion of this average to ON.

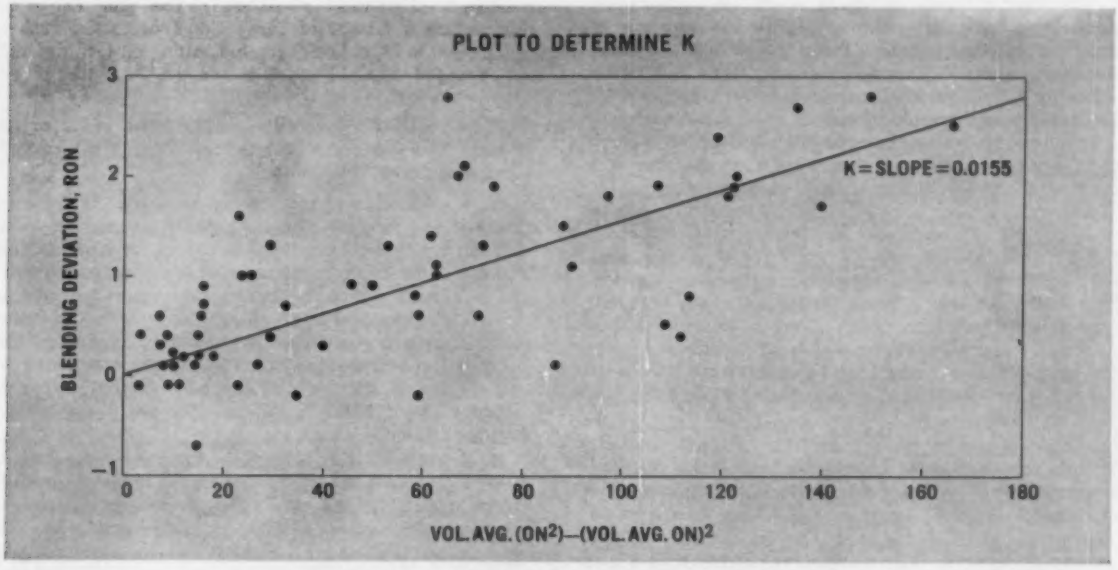
The table shows a comparison of standard error in RON for the four systems using 30 blends of 11 components. It is interesting to note that simply using component ENs compares in accuracy with the volumetric average using octane blending values by least squares. Accuracy is significantly improved when EN blending values determined by least squares are averaged volumetrically.

SUMMARY

Octane blending may be linearized by changing octane numbers to ENs using Ethyl's exponential scale. The method is equally usable with Research and Motor octanes and accuracy is improved over other known systems. It is directly applicable in linear programming.

COMPARISON OF STANDARD ERROR, RON

	Predicting Method			
TEL, ml/gal	Component ON	Octane Blending Values	Component EN	EN Blending Values
0.5	1.63	0.71	0.63	0.43
3.0	0.87	0.56	0.53	0.44



How Ethyl Research can help you

Mathematical Analysts in Ethyl's Refinery Technology Division will be glad to show you how the EN scale can be applied to your gasoline blending.

For an appointment with one of these specialists, see your Ethyl Representative.

Your Ethyl Representative also can supply you with copies of the paper, "Two Approximation Problems in Linear Programming of Gasoline Blending," presented at the computer conference of the Western Petroleum Refiners Association held in Tulsa, Oklahoma last December.

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Engineering Construction ROUNDTABLE

What five leading contractor executives say about their outlook, problems, service

FROM $1.5 to $2.0 billion are spent annually by operators on new process plant construction, additions, modernization or upgrading of existing plants. Much of this expenditure in one way or another is handled through engineering construction contractors. Their function has steadily increased in importance to the manufacturing industry. And, yet, they are each highly competitive and act independently of each other without the benefit of official organization, association or common spokesman. Little has been said or written about their key role in the process industry . . . their problems, practices or outlook. As written in *Refining Engineer* (February 1960) one leading consultant stated: "The engineer-constructors of the facilities (process plants) . . have but one brief opportunity to translate the refiner's expectations from paper into operation . . . and then it is cushioned by a very meager (profit) margin."

In order to provide a medium to "lay these problems on the table," *Refining Engineer* has asked several executives of leading engineering construction firms to give us their views on some pertinent questions facing their business. What is their outlook? . . . their problems? . . . what are they doing to meet increasing competition? . . . to improve their operations to provide better engineering services at reasonable prices? We are indeed grateful to these "pioneer" spokesmen bold enough to express their thoughts on these vital questions.

What do you think is the outlook for engineering construction during 1960? What processes hold the most promise for activity?

W. E. Waste: The outlook for refinery engineering and construction is improving. While in the United States very little crude capacity is expected to be added, construction of specialized refinery units and petrochemical facilities will raise total expenditures for process plant engineering this year above the amounts spent in each of the past two years. The processes selected for construction largely will be those which in individual cases offer the most attractive immediate return. A critical look is being taken at present yields and adjustments are to be anticipated.

J. F. Thornton: The outlook for engineering construction for 1960 is good; much better than in the past two years. We look for Catalytic Reforming and Coking to hold promise for activity during 1960. Petrochemical Processes to supply increased demands for various plastics are also expected to be quite active.

H. E. Widdell: The outlook for capital expansion in the petroleum industry is naturally clouded by the current overcapacity for producing refined products. There are, however, indications that some pickup in activity may be felt by the end of the year. For promise of activity it would appear that those devoted to upgrading of products to meet conditions in specific localities would receive the most attention rather than those designed to increase overall quantity or volume.

S. Sollitt: We consider the outlook for engineering construction to be very bright during 1960. Our interests are primarily in compounding, packaging and terminaling, all of which hold promise for 1960.

C. P. Lattin, Jr.: There are indications that new engineering construction business in 1960 will be improved over 1959, both in the domestic market as well as the foreign market. Most of the business placed this year will be for more efficient version of conventional processes, such as crude plant units, cat crackers, lubricating oil facilities, etc., which will replace old less efficient units.

Do you consider the foreign market holds better or less opportunities than the U. S.? Is local competition heavy in foreign countries? Which ones?

W. E. Waste: We look for improvement in both the domestic and foreign market. Responding to the growth in demand for refined products in many countries and the desire to have such products produced locally, a number of "grass roots" refineries are in various stages of planning. As a result, new business is developing outside the United States for the engineers and constructors. In Europe particularly local competition is getting increasingly important and American firms are finding collaboration with their European counterparts to be advantageous, particularly in engineering and drafting.

H. E. Widdell: It would appear that the overseas market holds more immediate opportunities for major engineering construction as the transition from a coal to a petroleum economy, which began in this country 50 years ago, is now moving into full swing in many foreign countries. This transition is being motivated by the general economic advances in Western Europe and by the natural population growth in the urban centers of South America, both of which create an increased demand for petroleum products.

C. P. Lattin, Jr.: The amount of engineering construction work in the foreign market will be considerably greater than that let in the United States. As far as local competition is concerned there are two factors to consider:

a. Many of the U. S. engineering construction firms have subsidiaries operating abroad which cannot be considered as competitive. It would appear that the companies will have a good work load in 1960. Although currency restrictions are easing, the fact that wage rates in these foreign subsidiaries are lower tends to drive the foreign buyer to these subsidiary companies so that he can have all or part of a particular contract executed by them, or;

b. He turns to a foreign-owned engineering construction contractor. These competitors are definitely becoming stronger because they are obtaining their governments' assistance, enabling them to quote prices on a long term payment basis. This local competition is greatest in Japan, Germany, Italy, and to a lesser degree, France.

Clark P. Lattin, Jr.,
Vice President,
Foster Wheeler Corporation

Sumner Sollitt,
President,
Sumner Sollitt Company

James F. Thornton,
President,
The Lummus Company

William E. Waste,
Executive Vice President
Bechtel Corporation

H. E. Widdell,
President,
Arthur G. McKee & Company

Which problems head the list for engineering contractors? How can they be solved?

J. F. Thornton: The main problems for the engineering contractors revolve around the basic issue of a satisfactory profit margin for this type of risk enterprise. There is no obviously simple solution to such a complex matter, but many ideas have been advanced, such as limiting the number of bidders per job, reimbursement for the preparation of estimates, etc. Present bidding practices involve heavy cost burdens to the engineering contractor and, in turn, to equipment suppliers. These costs may run to $50,000 or more per single bid on the part of the engineering contractor and an additional amount expended by equipment suppliers. The question of who pays the bill is a difficult one; a small portion of this charge might be deemed as ending up in the cost of the plant, but the crux of the matter is that most of these costs come out of what should be the legitimate profit of the engineering contractor.

There appears to be no mechanism for clarifying such matters and probably there should not be. A logical aim would be a continued interest and discussion of such problems for a better understanding on the part of all concerned and this can, to a degree at least, be achieved by media such as this Roundtable.

C. P. Lattin, Jr.: One of the major problems is the high cost of preparing specifications to define the work and to permit definitive estimating. Because of pressure from numerous engineering contractors, some purchasers fail to restrict the number of bidders so that the cost to the industry, both contractors and equipment suppliers, is reduced to a practical minimum without interfering with the competitive requirements. Also, there are some purchasers who will solicit bids prior to approval of the project by management, thus incurring expenses among several contractors before the job is a certainty.

If each purchaser will recognize the cost to the industry and the waste of engineering talent, and then, restrict the number of bidders, I believe that all engineering contractors will accept this policy even though they are disappointed at being eliminated from a specific bidding. Recognizing that it is often necessary to obtain definitive bids before final board approval of a project, it is recommended that the purchaser will reimburse the bidding contractors for their out-of-pocket costs when a project fails to receive approval.

During the very competitive situation existing in the past few years, there has been a tendency for purchasers to demand and contractors to accept greater risks and certain one-sided conditions that would not be accepted as good business practice. This problem can only be solved by the individuals in both purchasers' and contractors' organizations recognizing that no contract is a good one unless it is good for both parties.

W. E. Waste: The wasteful practice of inviting bids under conditions that require speculative engineering of each bidder before he can develop a reliable price is adding to the overall cost of refinery engineering and construction. Only the successful bidder has any hope of recovery . . . to the rest this work is a dead loss. While it is true that some of the cost is drained from the engineers and builders, most of it is added to overhead and therefore to the cost of future jobs . . . so that eventually the oil industry pays the bill.

What steps taken recently by engineering contractors will provide better engineering, cheaper? Has the contracting industry taken as much advantage as it should of new tools, such as higher mathematics, high speed computers, operations, research, systems engineering, etc.?

C. P. Lattin, Jr.: The most significant step taken recently by engineering contractors to provide better and cheaper engineering has been the introduction of models for use in design, obtaining approvals, and in construction. Allowing the contractor to submit his own designs and specifications in the bidding stage has resulted in the contractors putting more emphasis on finding ways to reduce the cost of a particular process or operation through simplification or improvement in the efficiency of the design offered. Increasing use of standards and computer operations is also reducing costs and improving quality . . . high speed computers, higher mathematics, operations research, etc., have definitely become a part of the better engineering contractor's operation.

S. Sollitt: Engineering contractors can provide better engineering cheaper only by specializing and standardizing methods. Not all contractors have taken advantage of the new tools as much as they should, but there is considerable improvement on this score.

J. F. Thornton: Some of the recent steps taken involve the use of computers, models, and other similar aids. Generally, engineering firms have taken advantage of all these tools, and quite obviously, this is a continuing effort. The amount of money which should properly be expended on the development of new engineering tools must, unfortunately, at times be influenced by profit margins.

H. E. Widdell: Engineering construction firms are continually trying to devise methods of doing the job less expensively, but this is a difficult assignment . . . cutting the cost is no substitute for being right. We have found a high speed computer to be of excellent use in cutting time in process calculations and we are continuing to make studies on ways of taking additional advantage of the capabilities of this type of equipment.

NOTE — DISCUSSION OF THESE REMARKS IS INVITED, either for publication or for the attention of the participants. Address all correspondence to REFINING ENGINEER — ROUNDTABLE, P. O. Box 1589, Dallas 21, Texas.

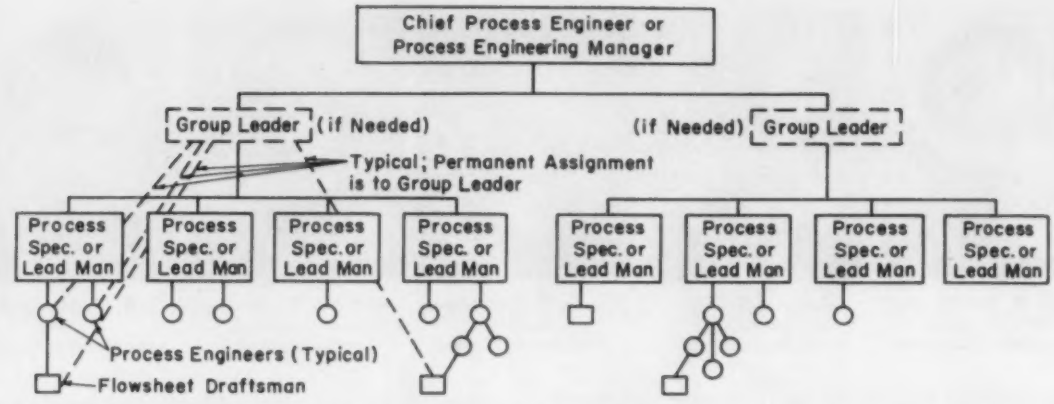

Chief Process Engineer or
Process Engineering Manager
Group Leader (if Needed)
(if Needed) Group Leader
Typical; Permanent Assignment
is to Group Leader
Process Spec. or Lead Man
Process Engineers (Typical)
Flowsheet Draftsman
NOTE: PROCESS ENGINEERS, ○, ASSIGNED AS NEEDED TO PROJECT
WHERE ABILITY ALLOWS, ANY PROCESS ENGINEER MAY BE ASSIGNED AS PROCESS LEAD MAN

FIG. 1. A process engineering section supervision chart — project basis.

A MANAGER REPORTS HOW TO SCHEDULE

Petrochemical Process Engineering

E. E. Ludwig
Manager, Process Engineering
Engineering Department
The Dow Chemical Company
Freeport, Texas

PROCESS ENGINEERING is the application of chemical, mechanical, petroleum, gas, and other required engineering talents to the process-related development, planning, designs, and decisions required for a process project. Although process engineers are organizationally located in research, technical service, economic evaluation, and certain levels of management, this presentation is limited to the management of process engineering in an engineering department. Even this identification requires recognition that process engineering in an engineering consulting organization and in a medium to a large chemical production company has some areas of difference.

THE PROCESS ENGINEER

The average process engineer prepares studies of process economics, process systems, and cycles; evaluates competitive bids; and designs and specifies the individual items of equipment to completely define a process flow system. The extent or degree of participation will vary with the company organization.

The process engineer develops and interprets data and information from the research pilot plant and establishes a process flow cycle for the process under consideration. From this step he proceeds to the detailed design and evaluation of the specific details of the engineering design of the process. As the basic chemistry of the process is established and the material and heat balances are completed, he brings into focus the interrelationship of chemical and mechanical engineering. This becomes more evident as the details of the individual items are designed. The individual units of the process must perform the process function in the mechanical equipment. Thus the mechanical interpretation requires a fundamental understanding of "how" the equipment performs its contacting, separation, heating, etc.

The process engineer must understand the interaction of the various research, engineering, construction, and operational functions of a project, if he is to place proper emphasis on each facet of the process. Some important areas of understanding include plant layout, materials of construction, start-up operations, trouble-shooting (technical service), etc.

The process engineer is expected to be a thinking and versatile technical engineer. Therefore, the basic nature of this type of individual requires that he be supervised in a somewhat different manner than some other engineers and draftsmen who are not necessarily involved in the developmental analysis and decision making of the process responsibilities.

ORGANIZATIONAL STRUCTURE AND ACTIVITIES

Engineering Construction

Process engineering is organizationally placed in a wide variety of positions in different companies. In a consulting engineering organization the process engineering is usually a separate group responsible for developing the process with the customer or presenting the customer with a turnkey proposed process. The process development and decisions all precede the initiation of any work in the other phases of engineering. After the basic process is established,

the planning phase begins and other engineering talents are integrated into the scheme in order to bring their respective requirements into focus for proper planning. At this point, preliminary sizes are developed to allow over-all layout planning to proceed. Here the use of models may be advantageous. The final detailed process designs follow the preliminary developments. Specifications suitable for inquiry and quotation are usually developed following the detailed designs.

Operating Company

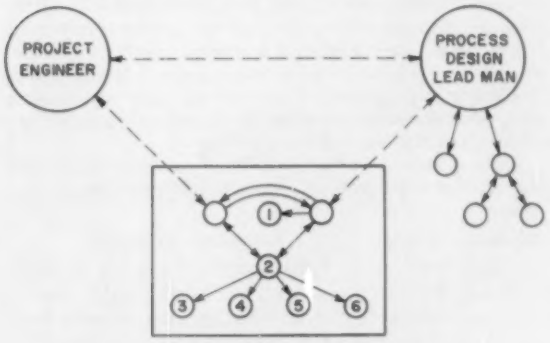
In the engineering departments of medium to large chemical companies, the process engineering usually follows the same basic path described above with the exception that

1. Initial information from research departments may be sketchy, physical properties meager, and work must proceed with many "judgment" factors thrown in;
2. Inquiries to vendors may be approximated in specification prior to detailed design, in order to partially develop the picture, then firmed up later;
3. Major changes in a project may enter at any time during the course of the job, as the results of new research developments are established; and
4. Phases of a project may be rushed to a partial completion to allow preliminary bidding for construction. There are many other factors which enter into the daily working relationships when the process engineers have access to production plants using similar basic unit operations. The operating performance of existing equipment may be evaluated in order to contribute a factor into the final design of a new project.

A somewhat general organizational arrangement for a process engineering section, group, or department is indicated in Fig. 1. Fig. 2 diagrammatically indicates the project planning team arrangement with the relationship of the members and the flow of information, designs, and specifications shown by the arrows on the lines. Note that **the project engineer and process engineer are a part of the team,** but also have other responsibilities.

WORK SCHEDULING

Scheduling of work in process engineering is a near impossibility as far as pin-pointed accuracy is concerned. The very developmental and planning nature of the early phases, as well as the continuous follow-through and follow-up, make this difficult. It is seldom that one can foresee specific changes, delays, etc. Here it is better to use past **average** experience for projects of the same type, class, and/or size. Even size does not always have a significant bearing on the schedule. Weighted judgment, taking the type of job, type of process, and type and nature of the men with the engineering and process responsibility into account is necessary to align a balanced and smooth-working team.



PLANNING TEAM

1 FLOW SHEET DRAFTSMAN
2 DESIGN SECTION LEAD MAN
3,4,5,6 MECHANICAL, ELECTRICAL, CIVIL, ETC. ENGINEERS AS NEEDED FOR PROJECT PLANNING

FIG. 2. Typical organization of "Engineering Planning Team."

ANALYSIS OF ACTIVITY

A time study of eight process engineers handling the complete scope of small and large projects has been helpful in accounting for legitimate time which was obviously not spent in performing calculations or other obviously related process activities. These percentages represent graduate engineers in responsible charge of or having an assigned process engineering responsibility in projects requiring abilities in organic and inorganic chemicals.

Table 1.

Activity of Engineers	*Percent of Time* Single Study	Avg. Range
Process design calculations	34.69	35-52
Conferences, consultation, unscheduled urgent assignments, information assembly	28.98	13-29
Supervision and administrative, including time schedules, discussions with salesmen, preparation of outside correspondence	4.45	4-15
Preparation of charts, forms, methods for benefit of over-all group	1.95	1- 3
Marking, checking, and reviewing flow sheets (no drafting)	10.94	9-12
Group meetings, training periods, over-all department and company development	1.80	1- 3
Literature review (current magazines, etc.)	1.80	0.5-2
Coffee breaks, etc.	5.55	4- 6
Unaccounted, including vacation	9.84	5-10

A somewhat more detailed breakdown separates the activities in a similar study:

Table 2.

Activity of Engineers	*Percentage of Time*
Consulting outside of scheduled jobs	4.4
Section supervision duties	4.7
Meetings related to scheduled jobs	13.7
Discussions with vendors	2.6
Special technical assignments	2.4
Communications within section	5.9
Process design calculations (original)	51.0
Process design calculations (checking)	3.7
Equipment schedules, line schedules, etc.	3.1
Flow sheet development, checking, revising (no drafting)	2.5
Coffee breaks, miscellaneous activity	6.0
	100.0

Since it is relatively easier to estimate the calculation hours for specific equipment items, the approximate total man-hours which might be expected for the total process engineering activity can be evaluated:

$$\text{Total estimated job man-hours} = \frac{\text{Estimated equipment man-hours (including checking)}}{0.45}$$

ESTIMATED EQUIPMENT CALCULATION MAN-HOURS

The required man-hours for a specific calculation vary with the process system, availability of physical data, and the relative familiarity of the process engineer. Records collected over a period of years on a wide cross-section of organic and inorganic equipment calculations are summarized in Table 3. It is impossible to accurately define the limits of the calculations represented, but on an average basis they have been found to be helpful in establishing the **order of magnitude** of the calculation time, as well as the basis for approximating the over-all extent of the process engineering of the project.

Table 3. Man-Hours Required for Equipment Design.

Type of Equipment	Design	Computer	Checking	Total M-H
HEAT EXCHANGERS:				
Solvent cooler	30	—	—	30
Tank heating coil	4	—	2	6
Caustic cross exchanger	32	—	6	38
Caustic cooler	8	—	2	10
Oil cross exchanger	32	—	5	37
Gas cooler	8	—	4	12
Compressor gas aftercooler	8	—	1	9
Slurry cooler	32	—	8	40
Finned tube exchanger	15	—	4	19
Gas cooler	2	1	—	3
CONDENSERS:				
Steam	7	—	—	7
Organic	6	—	2	8
HCl organic	10	—	11	21
Organic	1	1	—	2
Finishing	4	—	1.5	5.5
PARTIAL CONDENSERS:				
Organic — air	10	—	2	12
Organic — air	20	—	4	24
Organic — air	30	—	14	44
Inorganic — air	50	—	20	70
REBOILERS (THERMOSIPHON):				
Organic — steam	16	—	—	16
Organic — steam	20	—	5	25
Organic — steam	14	—	—	14
Organic — steam	10	—	5	15
Organic — steam	16	—	6	22
Organic — steam	14	—	5	24
Organic — steam	4	0.5	—	4.5
Organic — steam	5	1	—	6
Organic — steam	4	1	—	5
Organic — steam	2	0.5	—	2.5
Organic — steam	1	0.5	—	1.5
REBOILERS (FORCED CIRCULATION):				
Organic — steam	25	—	10	35
Organic — steam	19	—	8	27
Organic — steam	2	1	—	3
Organic — steam	3	2	—	5
DISTILLATION (PACKED):				
Carbonating tower	25	—	10.5	35.5
Gas cooler	20	—	8	28
Gas cooler	25	—	7	32
Cooling	16	—	22	38
Gas scrubber	24	—	4	28
Gas scrubber	12	—	8	20
Vent gas scrubber	5	—	1.5	6.5
DISTILLATION (TRAY):				
Organic — tray-by-tray	50	—	25	75
Organic — tray-by-tray	40	—	64	104
Demethanizer — tray-by-tray	31	—	22	53
Organic — tray-by-tray	35	7	4	46
Organic — tray-by-tray	4	5	—	9
Organic — tray-by-tray	5	6	—	11
Organic — tray-by-tray	2	2	—	4
De-ethanizer	24	—	15	39
Demethanizer	30	—	15	45
Organic — includes tray layout	24	—	28	52
Organic — includes tray layout	38	—	10	48
PUMPS				
System	8	—	6	14
Single	1.5	—	0.5	2
Single	1	—	1	2
Single	3	—	3	6
RECIPROCATING COMPRESSOR:				
BHP, temperature and	3	—	—	3
Data for vender rating	6	—	2	8
CENTRIFUGAL COMPRESSOR: About the same as Reciprocating above.				
PROCESS LINE SIZES:				
Single	0.5	—	—	0.5
Single	0.5	—	0.5	1
System, 22 lines	20	—	9	29
Air header for plant	4.5	—	2	6.5
SAFETY VALVES:				
Single	2	—	2	4
Single	1	—	1	2
STEAM TRAPS:				
System of 4	3	—	1	4
Single	0.75	—	0.25	1
Single	1	—	1	2
MISCELLANEOUS TANKS, DRUMS, ETC.:				
Condensate level drum	0.5	—	0.5	1
Steam flash drum	6	—	3	9
Storage tank	2	—	—	2
MATERIAL BALANCES:				
Depends on size of system.				

Note: The man-hours listed in this table included collection of needed physical and other data and preparation of a specification or summary of the requirements.

With the aid of a medium-size digital computer, calculation times may be summarized:

Table 4.

Calculation	Hours Total Elapsed Time Preparation + Calculation
Preliminary Distillation:	
Number of trays, reflux ratio	1-3
Tray-by-Tray Distillation	
To 40 trays	2-3
To 100 trays	3-5
Tray Hydraulics	
Bubble cap, sieve, perforated	1-3
Heat Exchangers	
Condensers, exchangers	0.5-1.0
Separators	0.5
Flash Vaporization	0.5
Oil Absorbers	1-3
Safety Valves	0.25

TYPICAL ACTUAL MAN-HOUR PATTERNS

Fig. 3, 4, and 5 illustrate typical accumulation patterns for the process engineering man-hours. In general, the smaller the project and the better defined the scope, the more the pattern of Project B is approached. Projects A or C represent the larger projects where there may be changes in plant capacity or location, as well as a concurrent pilot plant research program to continually obtain a "better" answer. The slow-down portions of the curves can be accounted for as significant changes in the process or process-related factors. In general, most large (six months or longer) process engineering projects undergo significant changes by the time 50 percent of the project has been completed. These changes may not be setbacks, but they are reflected in the ability of the project to properly utilize the available engineering man power in the "normal" manner.

Fig. 6 and 7 present some typical monthly requirements of process engineering for projects of different magnitudes. In most organizations of this type, the schedule is set by the available man power, and does not always represent all that could be accomplished if a limitless supply of qualified man power were available. In many cases, it is not feasible to place a large group on one project, since information, data, and decisions must be developed to properly and profitably utilize the extra man power.

When a limited time is available to complete the project, then this must be used to determine the estimates of man power:

$$\text{Average number of men} = \frac{\text{Estimated man-hours}}{(\text{Total elapsed weeks})\ (32 \text{ to } 35)}$$

Where: 32 to 35 represents the actual usable man-hours per 40-hour week per man, allowing for average sickness, vacation, jury duty, etc.

Maximum number of men = 1.67 (Avg. number of men)

Peak man power requirements will be needed from 30 to 50 percent of the total time schedule, unless other factors influence the timing. Sometimes this can be anticipated.

Fig. 8 and 9 present a summary of a large number of

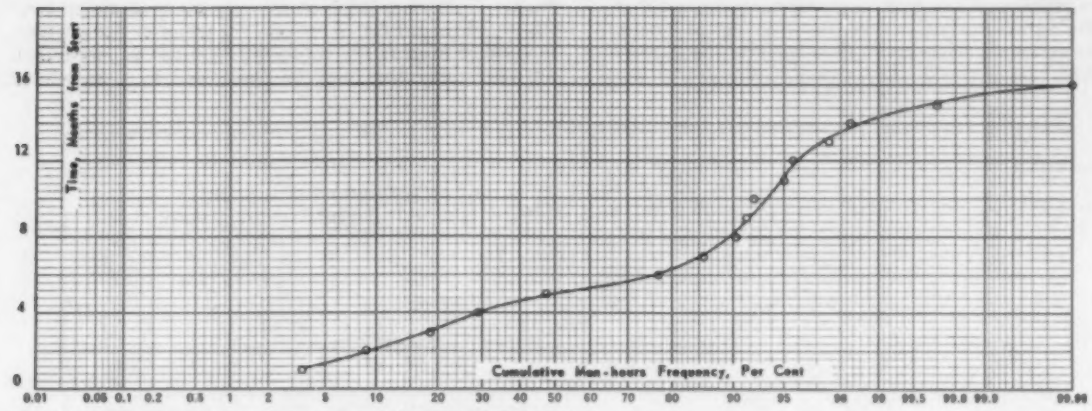


FIG. 3. Process engineering manhours accumulation pattern. Project A

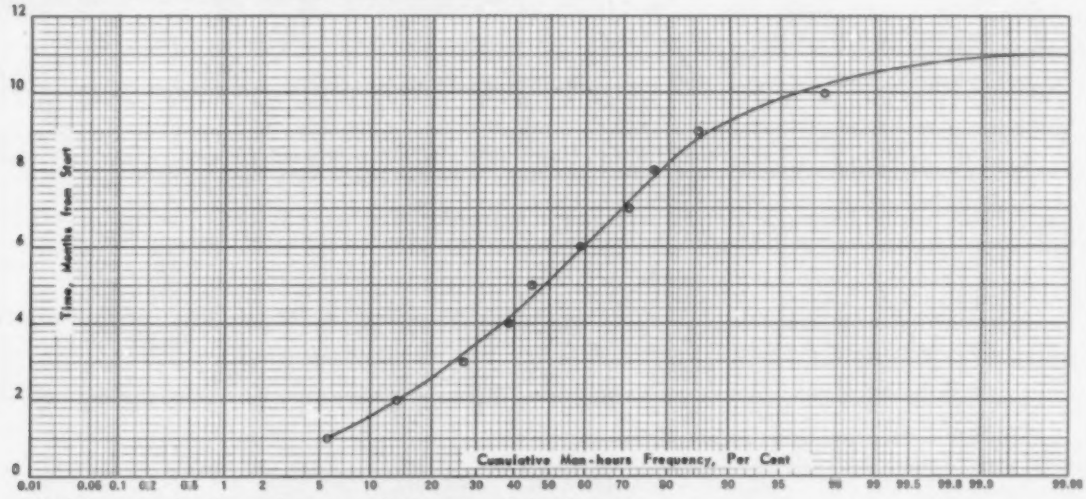


FIG. 4. Process engineering manhours accumulation pattern. Project B

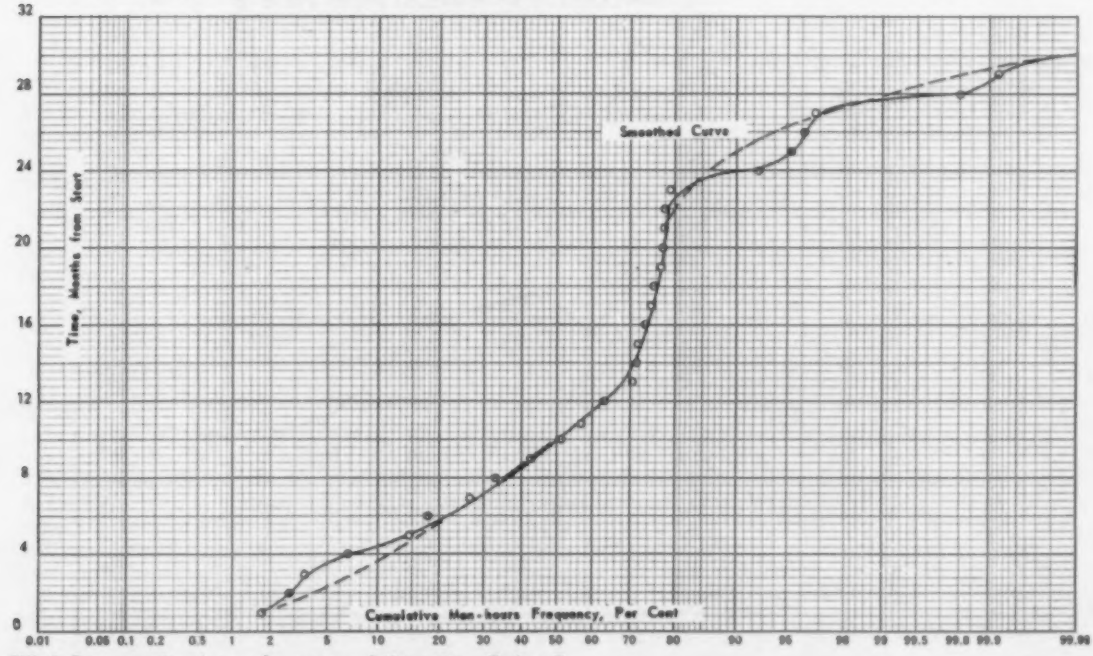


FIG. 5. Process engineering manhours accumulation pattern. Project C

projects engineered in a large chemical company and illustrate the variation that can be expected in the process engineering requirements for a given project. The percentage ranges may not hold true for projects handled by contractor engineering organizations. By studying the progress history of the individual projects, the major deviations from a so-called average straight-forward job can be recognized. In some cases, they may be anticipated by a knowledge

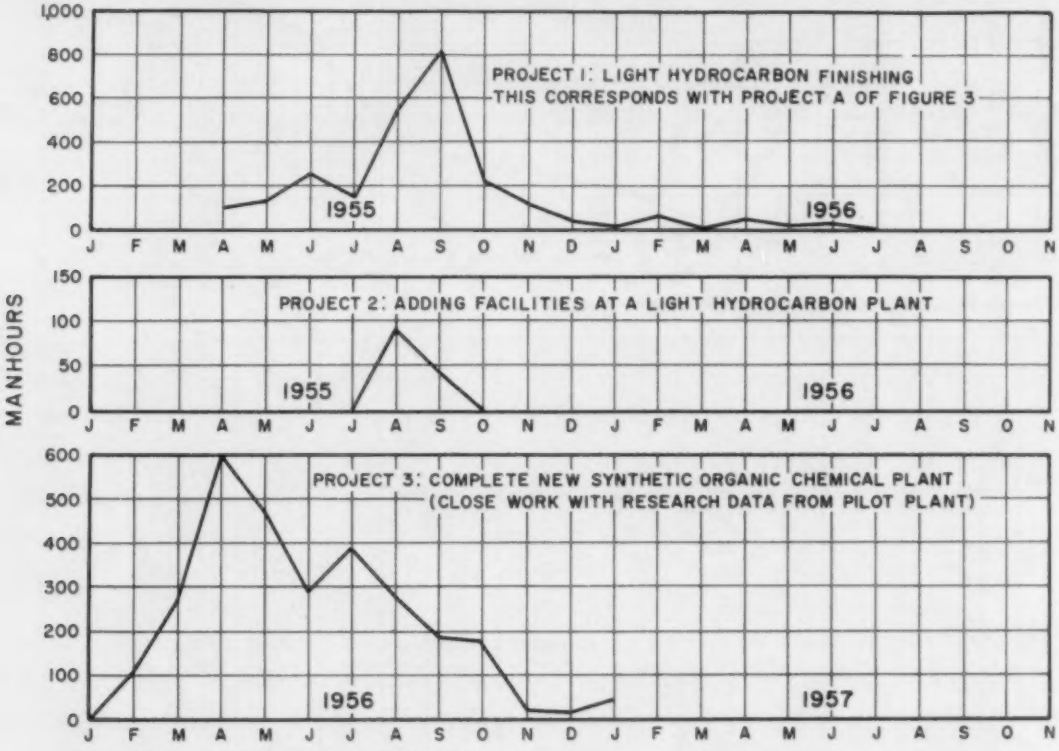

MANHOURS
PROJECT 1: LIGHT HYDROCARBON FINISHING
THIS CORRESPONDS WITH PROJECT A OF FIGURE 3
1955
1956
PROJECT 2: ADDING FACILITIES AT A LIGHT HYDROCARBON PLANT
1955
1956
PROJECT 3: COMPLETE NEW SYNTHETIC ORGANIC CHEMICAL PLANT
(CLOSE WORK WITH RESEARCH DATA FROM PILOT PLANT)
1956
1957
J F M A M J J A S O N D J F M A M J J A S O N

FIG. 6. Process engineering manhour requirements.

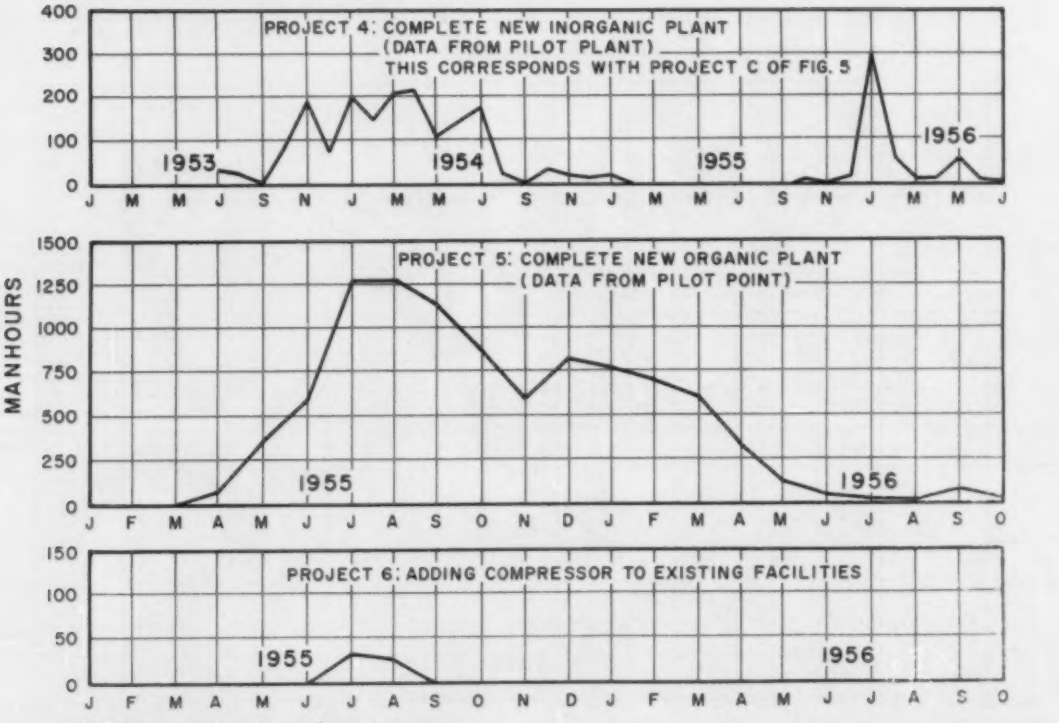

MANHOURS
PROJECT 4: COMPLETE NEW INORGANIC PLANT
(DATA FROM PILOT PLANT)
THIS CORRESPONDS WITH PROJECT C OF FIG. 5
1953
1954
1955
1956
J M M J S N J M M J S N J M M J S N J M M J
PROJECT 5: COMPLETE NEW ORGANIC PLANT
(DATA FROM PILOT POINT)
1955
1956
PROJECT 6: ADDING COMPRESSOR TO EXISTING FACILITIES
1955
1956
J F M A M J J A S O N D J F M A M J J A S O

FIG. 7. Process engineering manhour requirements.

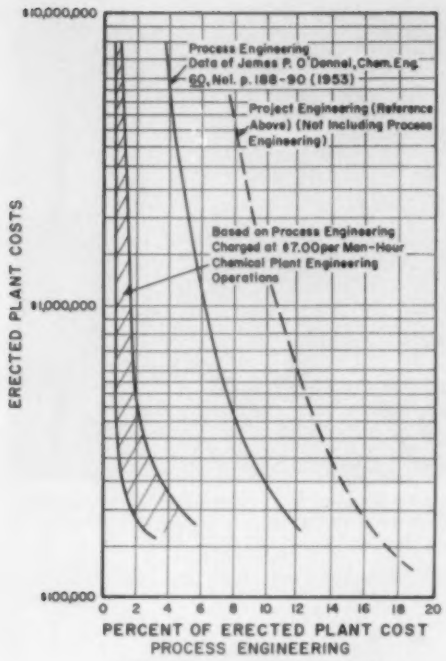


FIG. 8. Process engineering costs.

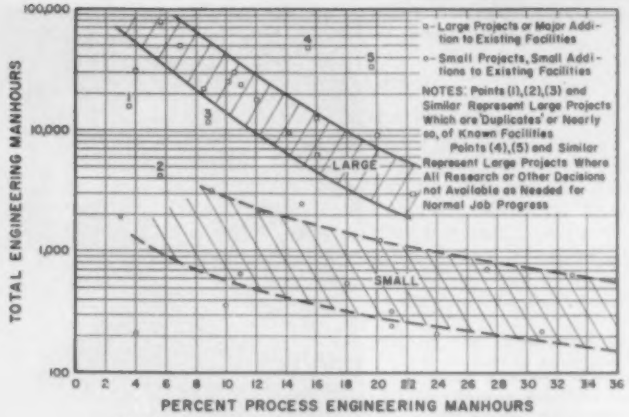

100,000
10,000
1,000
100
TOTAL ENGINEERING MANHOURS
o- Large Projects or Major Addition to Existing Facilities
o- Small Projects, Small Additions to Existing Facilities
NOTES: Points (1),(2),(3) and Similar Represent Large Projects Which are 'Duplicates' or Nearly so, of Known Facilities
Points (4),(5) and Similar Represent Large Projects Where All Research or Other Decisions not Available as Needed for Normal Job Progress
LARGE
SMALL
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
PERCENT PROCESS ENGINEERING MANHOURS

FIG. 9. Manhours for new construction or major additions.

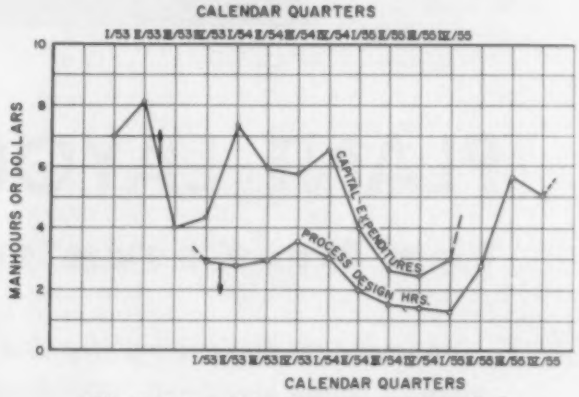


FIG. 10. Process design hours vs capital expenditures.

of the status of the process data prior to the start of engineering activity. The larger projects are somewhat easier to group than the smaller ones. Process engineering does not take the "completeness" stand on these as for the large jobs. This is to say that flow sheets may be simplified, detailed equipment and line schedules may not be required, and the over-all project can be completely visualized at the outset, which is not the case with large projects. The principal factor which runs the process engineering man-hours up is the comparison design studies of equipment or process schemes when compared to the relatively simple and limited work after the decisions are made.

LEAD TIME

The more complete the information submitted at the beginning of a project, the lower will be the process engineering costs. When the basic process can be designed and the flow sheet approved prior to initiating the detailed mechanical, structural, and electrical engineering, the project usually runs much smoother in the engineering department. This situation is more likely to occur in a contractor organization than a producing company engineering department. Process engineering usually leads the other work by one to three months whenever possible.

The relation of process engineering man-hours to the capital expenditures is shown in Fig. 10. Note that the curves are displaced about three calendar quarters.

ASSIGNMENT OF PERSONNEL

It is important to plan ahead for the proper assignment of qualified engineers to various projects as they arise. Jobs cannot be assigned on an "unconsidered" basis; that is, each lead process engineer and others in his group on a project must be selected for their (1) basic ability to understand the process under consideration, (2) background know-how, (3) design ability for the equipment involved, and (4) compatibility with the job project engineer and other key decision-making representatives with whom they will be in daily contact.

In general, it seems better to develop the engineers as over-all process generalists as contrasted to limited subject specialists. With the general approach, all of the personnel are urged to study and keep up to date in order to handle any type of project. This simplifies the assignment of the men, since there are more chances of having some available who are relatively strong in the needed specialties of a particular job. Each man will normally have an area of interest specialization and this can be utilized to a good advantage. At the same time it does not require that projects or specific designs be lined up waiting for the specialist. For the general approach there is a better appreciation for the exchange of views and understanding of specific design problems.

When the work is low it is important to have other assignments, such as design standards development or design procedures and methods, which can be prepared for long range use of the entire group. This in effect develops one man into a specialist for the subjects on which he prepares design procedures. The evaluation of field data is another facet of this type of study work.

Many engineering organizations must utilize the literature for their know-how development. It is necessary that they recognize the value and obligation in contributing some of their particular "know-how" back to their fellow engineers and scientists. Most organizations of this type are indeed in debt to the fine presentations of engineering studies and physical data in the published literature.

There are many other intangible factors which enter into the day-to-day contacts and decisions which must be made in managing a process engineering department. *Here is another phase of the engineering profession where judgment must be combined with facts to arrive at an effective and economical decision.* ★ ★ ★

The master layout of a refinery, large or small, is an all important step toward low costs for operations, maintenance, and growth.

— Photos courtesy C. F. Braun & Co.

PLANT LAYOUT . . .

The first step toward low cost

. . . an important engineering step that effects every major cost of a process plant . . . initial investment, operation, maintenance, safety and growth

Henry P. Evans
Staff Consultant
C. F. Braun & Co.
Alhambra, California

DURING OUR NATION'S GROWTH SINCE WORLD WAR II, management people, architects, engineers, and others, have focused considerable attention on the principles governing overall layout of commercial buildings, manufacturing plants, urban areas. Similarly, overall layout of process plants has received more and more attention in recent years.

Most engineers and many owners firmly believe that layout for a new process plant or for additions to an existing plant, is one of the most important engineering steps in the life of a process plant. Layout vitally affects a plant's financial performance. It affects every major cost of a process plant — first cost, operation, maintenance, safety, growth.

A study of many of the older process plants, quickly points up the fact that very few of them were properly planned. Considerable thought may have been given to efficient, convenient operation. But what about provisions for inevitable change? for growth? for economic effective maintenance? Often these things were almost completely neglected. In the end, these were the very things that proved to be the owner's nemesis.

METHOD OF APPROACH

In developing overall layout for a new process plant, engineers working closely with the owner should proceed, step by step, in this sequence:

Establish objectives to be attained,
Evaluate influence of the site,
Develop requirements and guides for the master layout,
Develop principles for layout of process blocks,
Consider use of plant models,
Study effect on costs, particularly maintenance.

OBJECTIVES

For this discussion of plant layout, let's use this same step-by-step approach. Let's start with the question, What are the objectives in laying out a new process plant?

Two primary objectives. Of the scores of older process plants that are well known in the refining and petrochemical industries, it is impossible to name a single one that has not undergone considerable growth, or major changes in some of its process units, or a much longer period of service than contemplated at the outset. Thus, layout of a new process plant should have two primary objectives. One is to create a plant that's low in cost at the very outset, as well as throughout its lifetime of operation and maintenance. The other is to provide adequately for growth and for change. Both of these objectives can be attained in such a way that they contribute to safe working conditions for personnel,

Layout of process plant should aim at grouping and grade mounting of equipment, access, ease of handling, and work space.

good public relations, and pride of employees in plant and company.

INFLUENCE OF SITE

When the area location for a new plant has been selected and available parcels of land are under study, most of the attention is concentrated on cost of the land, acreage available in a single parcel, zoning, proximity of utility services, highways, railroads, waterways, foundation conditions, water supply, and similar factors. Frequently, the site is optioned or purchased before even a preliminary overall layout of the plant can be prepared. Thus, when the layout of a plant is not all that it should be, the owner or his engineers may be inclined to blame the site and the limitations it imposed.

Fitting the site. Although a site should include as many desirable features as possible, experience has been that an ideal layout for a process plant can usually be fitted to any site selected, with little or no damage to the layout's effectiveness. An outstanding illustration of this is a large oil refinery in Europe. For economic crude supply by water and for other reasons, this refinery had to be located on an odd-shaped island in a river estuary. The ground was low, water table was high, soil bearing was poor, and access by land was limited. Yet overall layout of this large refinery is generally considered excellent from every standpoint.

Influence of site. Site selected influences overall layout mostly from the standpoint of orientation and very little as to arrangement of parts. For example, location of the nearest main highway will usually set the location for the administrative area. Location of the railroad and waterway will usually set the location for storage facilities for raw materials and products. Soil bearing or depth to rock will sometimes dictate the location for major process-structures. Topography may influence layout, but high capability of today's grading equipment makes this a rare situation. In rather isolated instances, topography may be used to provide gravity flow where such flow is highly desirable for economy or for efficiency of process.

Orientation of layout. Seldom is a layout simultaneously affected by a combination of many adverse factors such as rough topography, varying soil conditions, poor relative location of railroad, highway, and waterway. Often one or two of these factors may not be the best. But even then, they influence the layout more from a standpoint of plant orientation than from an increase in lifelong costs.

MASTER LAYOUT

When developing the master layout for a new plant, numerous requirements must be kept in mind, especially those pertaining to safety, utilities, local regulations, and codes. Usually these requirements are quite definite. And comparatively little leeway is available, particularly as to the effect of these items on operation and maintenance costs. **Factors to consider.** On the other hand, several factors that considerably affect operation and maintenance costs, are not usually controlled by safety rules, building regulations, local codes, and the like. Here are the principal factors to be considered, followed by some thoughts on the part played by each.

- Overall shape of plant,
- Size and shape of process blocks,
- Location and layout of plant-srvice area.
- Transportation services — trucking, rail, water,
- Provisions for growth and for change.

Shape of plant. Overall shape of the plant should be such as to facilitate operation, to produce short runs of major piping and utilities, and to reduce travel time to areas of major maintenance work. These objectives are best attained by using a rectangular or nearly square shape for the process section of the plant.

Process blocks. Next this rectangular or nearly square area should be divided into rectangular blocks of nearly uniform size. A block-size of about 300 ft by 500 ft has worked out quite well for many types of process plants. Sometimes a large process unit may require an entire block. But more often, a block will accommodate several units that are closely related process-wise.

Roadway, space for bundle pulling, and areas for field work, can all be together. This arrangement saves ground, gives good access, and simplifies clearance problems.

Road system. Each of these process blocks should have roads along all four of its sides to provide access for maintenance. These roads should be straight, paved and two-lanes wide. Roads bounding the process blocks thus establish the pattern for a rectangular grid system of roads for the entire plant. In addition, a paved accessway should run crosswise through the block from one road to the parallel road opposite. Usually this accessway can be positioned to be adjacent to each of the process units within the block. Travel of handling equipment from roads or accessways into the operating areas shouldn't be blocked by sleepered pipeways, vertical-face curbs, drainage ditches with steep sides. Jogs at intersections, sharp curves, and dead-ends should all be taboo. Any part of a plant should be accessible by road from at least two directions especially for personnel protection and fire fighting.

Plant-service area. Today's process plant usually needs supporting facilities such as administrative offices, clerical offices, control laboratory, changehouse for employees, cafeteria, maintenance shops, warehouse, garage. Generally these supporting facilities should be grouped together in a plant-service area, preferably located near the main entrance. Grouping these facilities together often reduces the number of separate buildings in a plant, since one building may be able to house several of these functions. Locating these facilities near the main entrance eliminates considerable pedestrian and vehicular travel through process areas. Maintenance buildings are a good example of these advantages. Shops and warehouse can be put into a single building. When the maintenance building is near the main entrance, delivery trucks and large vans need not drive through process areas to reach the warehouse.

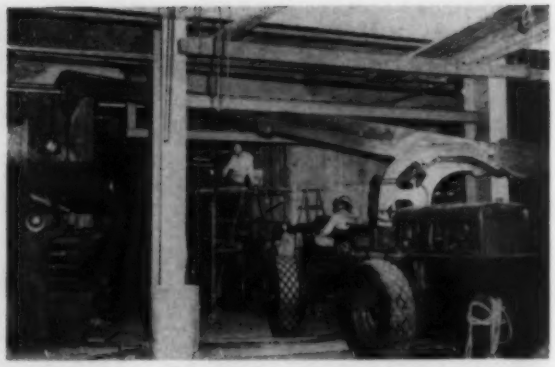
Transportation services. Considerable attention should be given to location of transportation services — particularly railroad trackage. Often a plant will need permanent trackage for receiving raw materials, for product shipping, and for receiving of other materials such as catalysts and treating chemicals. When not properly planned, trackage can be an obstacle to operations and maintenance. Facilities needing rail service should be located to minimize the number of spur tracks and the road crossings. A track should not be placed astride a roadway. Nor should a track be strung along several process units to reach the one unit that needs rail service.

Growth and change. One thing is quite certain — a new plant usually will grow and will change. A good layout will provide for growth in two ways. First, blocks for additional process area and for storage will be earmarked and clearly shown on the plotplan picturing long-range development. Second, space for adding bays to buildings or for adding process equipment at a unit will be dotted in on the block plans. This earmarked space can be put to profitable use in the interim period — for outside storage, for maintenance work-areas, or for certain permanent facilities that can be easily relocated at reasonable cost.

LAYOUT OF PROCESS BLOCKS

Regardless of how well designed, mechanically and from a process viewpoint, process equipment and entire units must be opened up, cleaned, inspected, and repaired at fairly regular intervals. This year-after-year work on the same equipment, offers a splendid opportunity to achieve low costs. For if provisions are made for this repetitive work in the layout and design of the process units, then maintenance can really be speeded up and simplified.

Maintenance factors. Overall objective in laying out a process block is to arrange the equipment to best satisfy



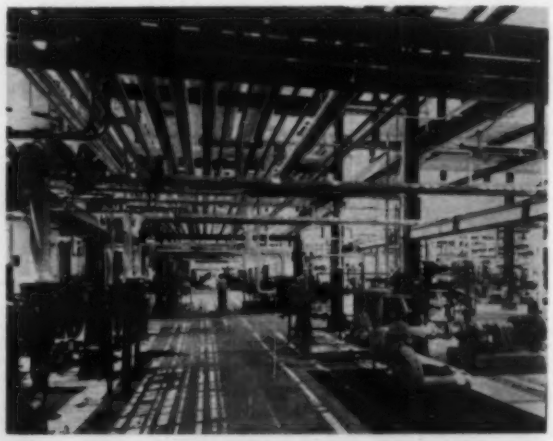
Capabilities of today's mobile equipment permits a more compact arrangement of some processes.

conditions of operation, maintenance, appearance, and cost. From the standpoint of maintenance, items deserving the most attention are:

- Grouping of similar equipment,
- Grade mounting of equipment,
- Work areas,
- Provisions for handling,
- Adequate space around equipment.

Grouping of equipment. Generally, major equipment is first laid out to accord with the sequence of process-flow. Then where economical, like items of equipment are grouped — first within the operating sections, next within the unit, and sometimes within adjacent units. For example, heat exchangers go in one bank. Pumps, in one row. Elevated condensers, on one structure. This grouping makes it easier and less costly to provide good access, adequate handling, and work space around equipment.

Mounting at grade. Where possible, grade-mounting of equipment should be used instead of elevated locations on structures. For example, condensers can sometimes be located at grade and thus eliminate completely the need for a structure and a tubebundle-pulling frame. This grade-mounting may increase plot-area needed. But it reduces investment in structures and cost of maintenance handling.



A through accessway, unobstructed with headroom, gives a process area the space needed for operations, maintenance, and for turnarounds.

Work areas. For major overhauls, maintenance crews need open work-areas at the process units. A work-area allows the maintenance department to move in and store equipment, materials, and tool trailers, prior to a major overhaul. During overhaul, maintenance men then have a place to set down disassembled equipment awaiting cleaning, inspection, or repair. They also have a place for certain work that's done more economically at the unit than in their shops. Often one work-area can be located to serve several process units. Each process block should have at least one such work-area. All work-areas should be paved, well-drained, and equipped with utility services.

Mobile equipment. Truck-cranes and crane-cars have been considerably improved in recent years. Today's equipment has more maneuverability, greater capacity, and longer reach than yesterday's. Thus, the trend in process plants is to provide more of the mobile handling units and cut down on built-in facilities for handling. Before laying out a unit, engineers should establish what mobile equipment the plant will have for maintenance handling.

Built-in facilities for handling. Under certain circumstances, built-in facilities for handling may be needed. Here are several cases where this is true. Heat exchangers and similar equipment located 40 ft or more above grade. Large compressors in line. Large relief valves that are beyond the reach of the plant's cranes. Tall structures housing large process equipment. Layout of a process block should provide for such built-in handling by providing space for monorail frames, lowering wells, gantry runways.

Space around equipment. In making the detailed layout of a block, designers should provide adequate space around equipment for operation and for work involved in plant maintenance. Some recommended clearances that should be provided are listed in Table 1. After space has been allotted around equipment, keen watchfulness is still needed during detailed design stage. Otherwise these clear spaces are often obstructed by motor-valves with their bypasses, pipesupports, piping, structural bracing, and the like.

Table 1. Recommended Clearance Around Equipment.

Headroom	
Over main roads	16'-0"
Over secondary roads	12'-0"
Above floors in buildings	7'-6"
Above elevated platforms	7'-6"
At grade in operating areas	9'-0"
Horizontal Clear Space	
Operating aisles	6'-0"
At shellcover end of exchangers at grade*	8'-0"
At channel end of exchangers at grade*	5'-0" + tubebundle length
Exchangers elevated on platforms, from either end to handrail	4'-6"
Around exchanger units, aisle between piping	3'-0"
Between shells of adjacent horizontal vessels	4'-0"
Around pumps, between piping	3'-0"
Elevated walkways	3'-0"

*Measured from shell flange.

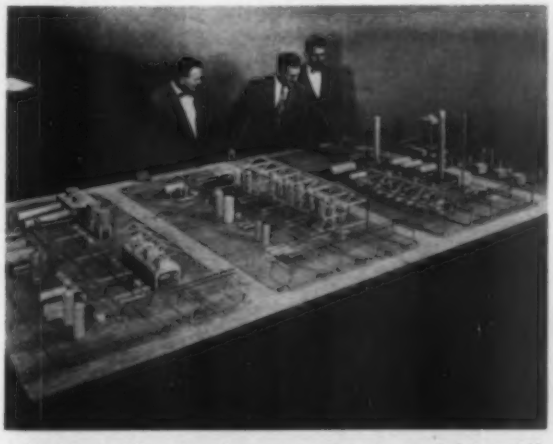
Design considerations. Much could be said about the effect of initial design on year-after-year cost of maintenance. Briefly though, items listed below are ones meriting close attention.

- Standardization of type and of manufacturer for widely used equipment.
- Use of quickly removable elements such as those available in heat exchangers.
- Arrangement of piping for ease of removal where it connects to process equipment, valves, and the like.
- Provision of utility stations in operating areas.
- Proper location and sizing of manways.
- Provision of work platforms on elevated equipment.
- Sizing and tooling of maintenance shops and warehouse.

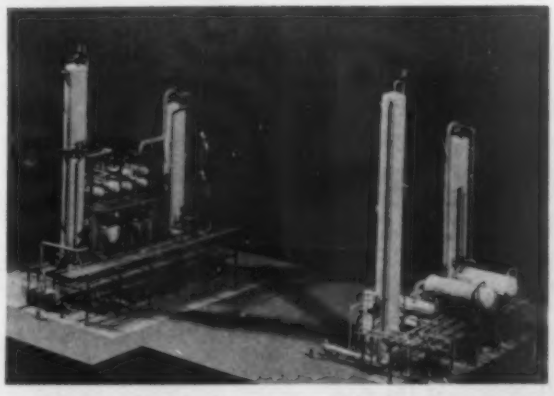
USE OF PLANT MODELS

Any broad generalization on the use and advantages of models is likely to be misleading. What's good for one situation may be wasteful for another. When a model is needed, it should be conceived for specific purposes and should be built solely to fulfill those purposes.

Cutouts and sketches. Development of layout for a new process plant is essentially a problem of comparing alternative arrangements for physical things that shape a plant. When the third dimension can be easily visualized, various arrangements are most quickly developed by use of cutouts. Arrangements developed can be recorded by freehand plan-sketches on grid paper. Use of cutouts and sketches will



A block-type of layout model may sometimes be needed to quickly develop and secure agreement on the best layout. From the left, Braun piping engineer C. A. Christiansen, project engineer J. I. Brewster, and owner's project engineer L. C. Cunningham.



Two engineering models of the same type of unit portray two vastly different concepts. Model on left shows the more conventional layout and arrangement. Model on right aims at lowest first cost with reasonable provision for operation and maintenance.

usually narrow down the alternative arrangements to two or three, to be considered in detail.

Plant layout model. The plant may be large or extensive. Or it may have elevated structures that make difficult the complete visualization of the third dimension. Or it may have characteristics that point to a model as a valuable aid in preparation of working drawings. For such a plant, a layout model is built to a small scale, equipment is represented by blocks, piping is not shown, and painting is usually omitted. This type of model is sometimes called a block model or a planning model.

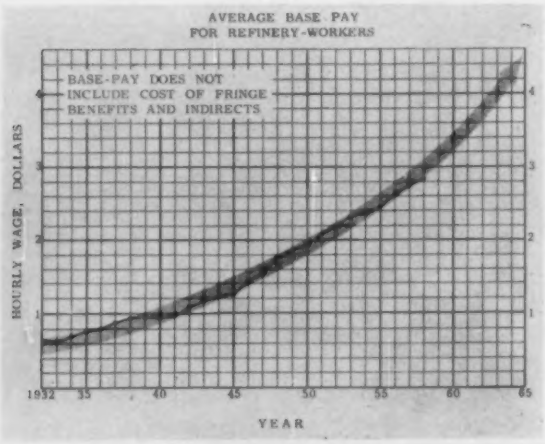
Engineering model. The plant layout model should not be confused with the engineering model. An engineering model is usually built to a larger scale, equipment is built representative of shape and dimension. Piping is usually formed of stiff wire with discs to indicate diameter. The engineering model is developed concurrently with the design and is most frequently used to plan process units where layout problems are unusually complex, or where new techniques or sequences of construction are to be used. An engineering model is more costly than a plant layout model.

Applications. A plant layout model can be an effective tool for working out the best arrangement for process blocks, arrangement of equipment, road system, accessways, plant-service area, railway trackage, utilities, and similar major features. It is not as suitable as the engineering model for seeing that adequate provisions for operation and maintenance within the process blocks are tied in exactly as needed.

Complete model. Sometimes a complete model may be needed for training of plant personnel, for demonstration, or for public relations purposes. Usually for this type of model, piping is to scale including the diameter, equipment corresponds in more detail, painting is complete and accords with a selected color code. Thus the complete model is more costly than either of the other types. Seldom can such a realistic model be economically justified from the standpoint of design or plant layout alone.

EFFECT ON COSTS

Good provisions for operation and maintenance in the layout of a new process plant usually show up physically in several ways. Total length of roads may increase somewhat. Providing adequate space around equipment may increase length of straight piping and amount of area paving. Several pipeways may have to be elevated rather than run on sleepers. Railroad trackage may decrease. Providing of work-areas will increase amount of paving and could increase investment in sewers.



The upward trend in the cost of labor and other expenses, presents an endless challenge to the industry.

Initial investment. It's almost impossible to come up with a dollar or percentage figure for the effect of these provisions on first cost, without making a detailed cost comparison for a specific plant. However, it's important to remember that investment in roads, railroad trackage, area paving, and straight piping above and below grade, makes up a relatively small part of the total investment in a new process plant — perhaps somewhere around 8 to 12 percent. And, with the good provisions all we are talking about here is a small part of this 8 to 12 percent.

Expense dollars. Providing for operation and maintenance through good layout, usually increases the first cost of a new plant, even though each provision is checked and found economically justified. Surprisingly though, this incremental investment often saves so many expense dollars that it has a better payout than the overall investment in plant.

Illustrative example. Let's take a $26,000,000 chemical plant, where not the best attention had been paid to factors discussed above in its layout, either initially or as the plant grew. A survey of this plant was made when it was about 10 years old. The expenditure for maintenance labor alone was running $1,300,000 a year. To improve the layout, an expenditure of $140,000 was required to install several additional roads, pave some existing roads, relocate certain trackage, add area paving, and provide some built-in facilities at several of the process units. This $140,000 expenditure, about one-half of one percent of the total investment in plant, would have been even less if the improvements had been included in the original design.

The payout. Using a rule-of-thumb basis, this $140,000 investment pays out in two years, if the maintenance labor bill is reduced by as little as six percent a year. Yet based on the experience of other plants, the investment in these improvements when coupled with a larger investment in proper maintenance shops, warehouse, and garage, would reduce the expenditure for maintenance labor by 20 to 30 percent. The detailed investment analysis for a specific plant should usually reflect the effect of taxes, depreciation, financing, and other factors. Such detailed analyses lead essentially to the same conclusion, namely that properly laying out a new plant has a real payout from several sources — operation, maintenance, safety, growth.

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★ ★ ★

HENRY P. EVANS, *Staff Consultant for C. F. Braun & Co., has had extensive experience in the layout, design, construction, and maintenance of many plants — especially oil refineries, petrochemical, and chemical plants. In the early thirties, he graduated from the Carnegie Institute of Technology and from the University of Iowa with degrees in civil engineering and hydraulic engineering. He was affiliated with the U. S. Bureau of Reclamation, the University of Illinois, and the U. S. Army, before joining Braun in 1947.*

Tangential Reactor Acetylene

Licensed by: Perco Division, Phillips Petroleum Company, Bartlesville, Oklahoma

DESCRIPTION: Phillips Tangential Reactor Acetylene Process... Preheated feedstock is introduced axially and is mixed intimately with the hot combustion products from the tangential feed. Acetylene is produced under the favorable conditions of high temperature, low pressure (essentially atmospheric) and very short contact time, in the smaller diameter portion of the reactor. Reaction is stopped by a primary water quench near the outlet end of the reactor.

Following the primary quench, the gases are further cooled in a two-tower, recirculating oil quench system. Use of oil, rather than water, for this secondary quench removes heat from the gases at a high-temperature level which permits the dissipation of heat through air fin coolers or heat recovery by exchange.

Compression of the gases from the secondary quench tower requires only moderate power since a low pressure recovery system is used. The compressed gases then pass through a series of heat exchangers, knockout drums and bauxite drier to remove moisture prior to absorption in the dimelthylformamide (DMF) recovery section. After drying, the gases are processed in the DMF acetylene absorber which selectively absorbs all the acetylenic compounds of the gas stream at low pressure and temperature.

Residue gas passes overhead from the DMF absorber and the acetylene rich solution from the bottom of the column passes next to a CO_2 stripper. Overhead from the CO_2 stripper is recycled to the DMF absorber to recover the small quantity of acetylene contained in this stream. From the CO_2 stripper the rich DMF stream enters the acetylene stripper where acetylene is removed from the rich DMF solution and passes in gaseous form out the column overhead. The lean DMF stream is then recirculated to the DMF absorber. The gas stream leaving the top of the acetylene stripper is rich in acetylenes but contains substituted acetylenes which are then removed in order to further purify the product.

The last step in the purification is accomplished in the heavy acetylene absorber which uses heptane as the absorber oil. Having dry feed for the heavy acetylene absorber again permits a low-temperature operation which in turn decreases heptane absorbent circulation and also minimizes loss of heptane in the overhead acetylene product. The heavy acetylenes contained in the rich heptane from the bottom of heavy acetylene absorber are removed as an overhead product in a stripper. Lean oil from the bottom of the stripper is recirculated to the heavy acetylene absorber column.

A versatile batch rerun column, not shown on schematic diagram, is provided for periodic cleanup of the DMF and heptane absorbents.

FEEDSTOCK AND YIELDS:

Under similar operating conditions, all of the feedstocks except natural gas give substantially the same acetylene concentration. Ethane shows an appreciably higher acetylene yield than propane or butane under comparable operating conditions. Air and oxygen give substantially the same yield with the acetylene concentration being cut approximately in half by dilution with nitrogen when air is used as the oxidant.

The ability of the tangential reactor to produce acetylene in attractive yields and concentration when using air is an important advantage. Complete feedstock and yield analysis can be obtained.

ROYALTY . . . rates on the complete process, including reactor and purification facilities are: Running royalty rates is $0.003 for each pound of acetylene produced and recovered; Fully paid royalty is $0.015 for each annual pound of acetylene.

INVESTMENT:

The estimated plant investment, including the tabulated off-plot facilities, engineering and construction fees, and contingencies are shown below. The battery limits investment includes necessary refrigeration equipment.

INVESTMENT SUMMARY

Battery Limits Investment:	
Reactor Section	$ 850,000
Purification Section (including quench and downstream equipment)	$3,580,000
Off-Plot Facilities	990,000
	$5,420,000
Engineering and Construction	1,080,000
	$6,500,000
Contingencies	900,000
	$7,400,000

OPERATING PERSONNEL:

Technical and Supervisory	8-1/2
Operating and Laboratory	28

ACETYLENE MANUFACTURING COST

BASIS: 50 MM Lb/Yr complete plant basis (with off-plot) butane-preheated air.

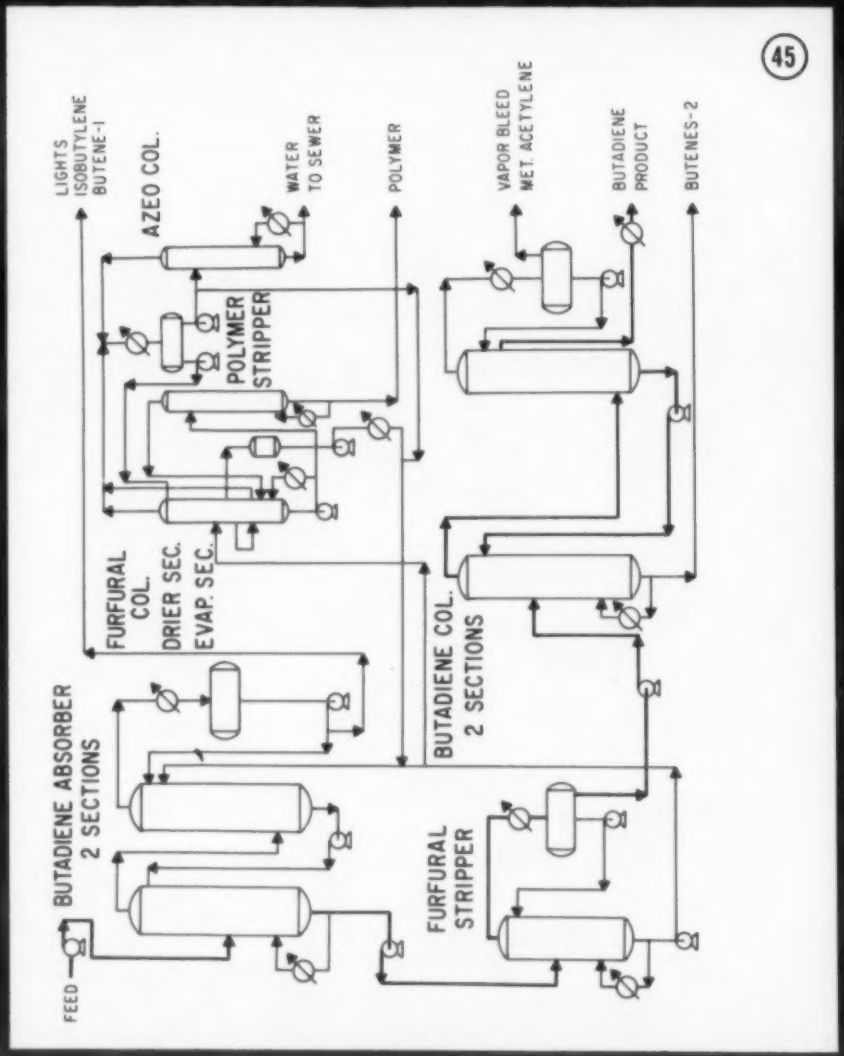
	$/Year	¢/Lb
Feedstock	$1,306,000	2.61
Utilities	$ 467,300	0.93
Supplies	$ 239,900	0.48
Labor	$ 406,800	0.82
Indirect Expenses:		
10% of Investment	$ 740,000	1.48
Royalty $0.003/Lb	$ 150,000	0.30
Amortization 15 Yr Declining Bal (Avg. for 5 Yrs.) Based on $7,400,000 investment	$ 756,400	1.51
Total Manufacturing Costs based on 90% service factor	$4,066,400	8.13

ACETYLENE PLANT PAYOUT PERIOD

Plant Investment including off-plot facilities	$7,400,000,	Total	
Acetylene Sales Price, ¢/lb	11	12	13
Payout Period, Years	5.12	4.39	3.85

Separation Process

Licensed by: Perco Division of Phillips Petroleum Company



Separation Process

Licensed by: Perco Division of Phillips Petroleum Company

DESCRIPTION: The C_4 cut from which polymerization grade butadiene is to be recovered is charged directly to the furfural extractive distillation column. Minor amounts of propane or propylene can be tolerated in the feed. Lean furfural is charged as a solvent near the top of the column. The column acts as an absorber and the butadiene is preferentially absorbed in the furfural along with small amounts of other C_4's. The absorber is reboiled to control the point of separation.

The rich furfural leaving the bottom of the extractive distillation column is pumped to a stripping column where the butadiene and other C_4's are removed. The lean furfural from the bottom of the stripper is recirculated to the absorber. A small lean furfural stream is taken to the furfural rerun unit for purification.

The hydrocarbon overhead product from the stripper is charged to a final column (the butadiene column). In the butadiene column butenes-2 and C_4 acetylene are removed as a bottoms product. The butadiene, 98.5 to 99.5 weight per cent is produced as a sidedraw or an overhead product from this column. The sidedraw is used to produce butadiene only when it is necessary to reduce the methyl acetylene content of the product.

The furfural extractive distillation process can also be used to recover butylenes from a mixed hydrocarbon stream for alkylation or chemical purposes. Any desired butylenes purity can be yielded by adjusting column operating conditions.

The main present use for butadiene is in the manufacture of SBR rubber. It is also being used to make the new polybutadiene rubbers. Butadiene may also be considered as a raw material for the manufacture of nylon and thermosetting resins.

TYPICAL STREAM COMPOSITIONS

Weight Per Cent

	Butadiene Recovery				Butylenes Recovery		
COMPONENT	Feed	Column Overhead	Stripper Overhead	Butadiene Product	Feed	Column Overhead	Stripper Overhead
Propylene	1.3	2.2					
Propane	0.4	0.6					
Methyl C≡C	Trace	-	Trace	Trace			
Isobutane	1.0	1.6					
Isobutylene	18.1	29.4	0.1	0.2			
Butene-1	31.4	51.0	0.2	0.3	1.1	1.4	1.3
Butadiene	29.2	0.6	76.2	98.5 to 99.5	0.3	-	0.4
N-Butane	2.8	4.5			71.0	94.0	1.9
Trans Butene-2	8.2	9.5	6.1	0.8			
Cis Butene-2	4.1	0.6	9.3		27.6	4.6	96.4
C_4 acetylenes	0.2	-					
Pentanes Plus	3.3	-	8.1				

UTILITIES

Steam
150 PSIG ..... 500 lbs/ST of Butadiene Product
300 PSIG ..... 14,500 lbs/ST of Butadiene Product

POWER

70 KWH/ST of Butadiene Product

COOLING WATER CIRCULATION

85° F H_2O 20° F Rise
75,000 gallons/ST of Butadiene Product

CHEMICALS

Furfural ..... 4 lbs/ST of Butadiene Product
Miscellaneous Chemical ..... $0.17/ST of Butadiene Product

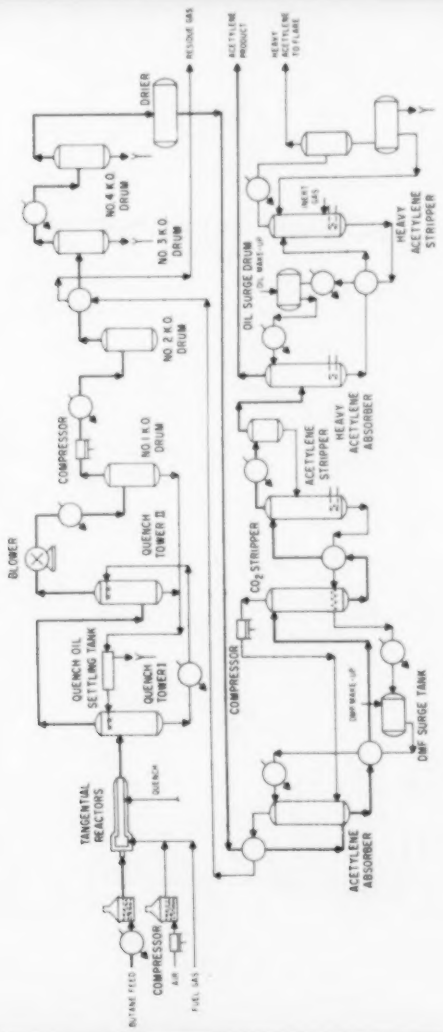
OPERATING LABOR

2 men per shift

Service Factor ..... 95+
Battery Limits Investment ..... $85 to $95 Per Annual Short Ton of Capacity

Tangential Reactor Acetylene

Licensed by: Perco Division, Phillips Petroleum Company, Bartlesville, Oklahoma



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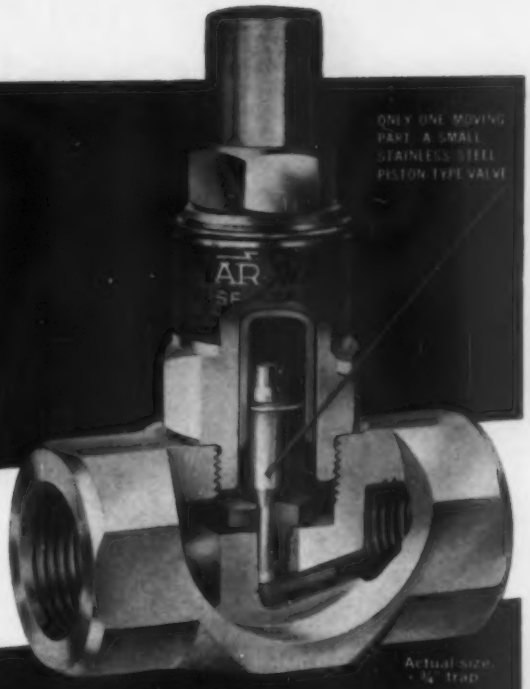

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In designing new plants, the design engineer should . . .

Consider SAFETY During Engineering and Construction

Here are the measures one company takes during design and construction to insure that the finished plant is adequately safe

J. J. Graham
Engineering Supervisor
The Standard Oil Company
Cleveland, Ohio

SAFETY is a factor which must be considered every step of the way in the planning, design and construction of new refining facilities. At Sohio it is incorporated in the primary objectives which have been established for any new processing facilities:

1. Desired quantity and quality of products.
2. Adequate safety.
3. Reasonable operating and maintenance costs.
4. Lowest investment cost consistent with (1) to (3).

Starting with approval to build a new process unit there are seven steps in the chronology of a project where safety is of special importance:

1. General engineering specifications.
2. Job specifications.
3. Engineering flow sheets.
4. Plot plan.
5. Model review.
6. Construction inspection.
7. Prestartup operator training.

GENERAL SPECIFICATIONS

Engineering on a job usually starts with general specifications and standards. They set down, in words and graphically, the things desired in the principal classes of equipment in a refining unit: vessels, furnaces, exchangers, piping and so on. These publications have been developed over the years by the engineering division and contain the items that are necessary to safety, ease of maintenance, and satisfactory service life.

A general specification on pressure vessels, for example, was originally prepared some years ago. Following discussions with operating people, manufacturers, contractors and others, it has been revised at frequent intervals since then, to incorporate new ideas, methods or materials. It insures good vessels . . . **not "gold plated"** . . . but including features which contribute much to safety in operation and maintenance.

A design pressure, usually not less than 15 lb over the operating pressure, reduces the frequency of relief valve discharges caused by pressure surges and the accompanying flammable hazard.

Here a group of Sohio engineers are reviewing a proposed engineering standard. Pictured left to right are: Ridenour, Kerns, Goller, Mills, Wright, and Davis.

Alloy liners and/or adequate corrosion allowances are provided to postpone or eliminate extensive internal maintenance work.

Sectional trays are used and a maximum weight limit placed on individual pieces. This reduces the danger of sprains and strains, which accompany heavy lifting in awkward circumstances.

Manholes are located at points where frequent cleaning or inspection is anticipated. The covers are hung on davits, in an effort to avoid injury to boilermakers, straining to lift them or accidentally dropping them.

A fixed internal ladder is another feature which contributes to the safety of these vessels. It leads down from an access manhole to the bottom of the vessel and has a conveniently located internal grab bar above the manhole.

These are some of the ways to build safety into vessels. Piping is another area, where much thought has been given to incorporating safety in design. Double block and bleed arrangements to avoid intermingling oil vapor and air . . . welded joints, instead of screwed or flanged wherever feasible, to forestall flange or gasket leakage . . . permanent spectacle blanks at the battery limit, to simplify the job of blinding all incoming and outgoing lines at the plot boundary, prior to any general maintenance shutdown . . . limiting the use of cast iron and brass within battery limits to water and low pressure steam lines, due to the inadequacy of these materials in fire . . . providing access platforms or chain operators at elevated valves . . . insulation for personnel protection on lines near grade or platforms . . . and on and on.

As with vessels and piping, general specifications for other types of refining equipment incorporate features which experience has shown are needed to insure an adequate level of safety.

JOB SPECIFICATIONS

The general specifications, as the name implies, are intended for all types of refining units. Obviously, they must be modified to suit a specific type of unit in a specific location. This is usually done by job specifications. These set forth the process requirements of the job in question, as well as the modifications of the general specifications which apply to it. Here, too, is another place where safety is an important consideration.

For example, the job specification will establish the extent of pumpout facilities required for an orderly shutdown in an emergency. It will set forth the extent of blowdown system needed to collect relief valve discharges — thus limiting atmospheric discharge to non-flammable materials or those high enough above grade and light enough to disperse without hazard.

Safe disposal methods for waste materials, such as hydrogen sulfide and caustic, are spelled out. Reliable inert gas purge methods are required in units involving intermittent regeneration with air. Where flue gases from fired heaters are expected to contain significant amounts of sulfur dioxide, maximum ground level concentrations are established. These, then, are translated into proper stack heights, to preclude exceeding the maximums set.

Job specifications also indicate the type of tank roof required in various services — generally cone roofs for heavier materials and floaters for lighter materials and those in which explosive air-vapor mixtures might be expected, a large portion of the time.

Some considerations for pump and compressor buildings are often covered. If, for some reason, a building cannot be avoided completely, an open-sided one is used, adequately vented at the peak of the roof. This seems to be the safest from the standpoint of accumulation of vapors and yet providing weather protection — though not as safe as no building at all.

In addition to these aspects of safety, job specifications cover all major design bases — size of plant — feed characteristics — quality and quantity of products required — soils data — utilities available, etc.

FLOW SHEET REVIEW

The next phase of the engineering work, where safety plays an important role, is in the preparation and **careful review of the flow sheets.** By flow sheets, is meant the diagrammatic representation of all the piping, instrumentation, and process equipment in the entire job — not only the oil lines, but the steam, water and gas lines as well. The review of these flow sheets is the **first of three very important places,** in which to design safety into a new facility. The others are in plot plan layout, and model review, which will be discussed later. These flow sheets enable the engineer to establish, in his mind, the interrelation between all the parts of the plant and to visualize the effects in other areas of an upset or emergency, at any point in the system. Here, too, is a good place to plan safe, orderly startups and shutdowns, both routine and emergency. In this planning, the assistance of operating foremen who have had experience on like or similar units is invaluable.

In flow sheet reviews, Sohio calls upon the combined knowledge of operating people, process and mechanical engineers, equipment specialists, and safety people, so that the end product can most closely fulfill the primary objectives mentioned earlier — adequate safety — reasonable operating and maintenance costs — and minimum investment consistent with these.

Sufficient instrumentation is provided for safe, stable, and economical operation. Alarms are provided, largely on levels or temperatures, where immediate action by the operator is essential, to prevent hazard to men or major equipment. In specific cases, alarms and automatic shutdowns are set in series. For example, a high liquid level alarm is often installed on the suction drum for a compressor and a very high level alarm and automatic shutdown as well. In this way, the operator is warned to take corrective action, but if the action he takes is not quick enough or not sufficient to prevent the level from rising further, he and the machine are protected from injury by the automatic shutdown. Of course, the early alarm could be omitted, but this would lead to more frequent emergency shutdowns, which involve potential hazards themselves. Regarding the use of alarms, it should be realized that they must be installed sparingly. Too many alarms, used where no real serious emergency exists, will blunt the effectiveness of all the alarms. The boy who cried wolf had much the same experience, you will recall, in the old Æsop's fable.

Another point to examine, is the effect of loss of control air on instrumentation. As much as possible, the control valves are specified to "fail safe" on air failure — to move to either the open or the closed position with loss of air, depending on which position will result in the least hazard.

On the flow sheets, it is possible to examine complete flow circuits to determine whether there is overpressure protection for all parts of the system, not only during routine operation or startup or shutdown, but also during misoperation — say, due to a valve inadvertently left closed. Here, too, is the opportunity to specifically select the best route to direct relief valve discharges — to flare — blowdown drum — sewer or atmosphere.

Flow sheets are a good place to make sure that enough valves are provided, to permit safe, on-stream maintenance, if this is contemplated. Look for installation of such things

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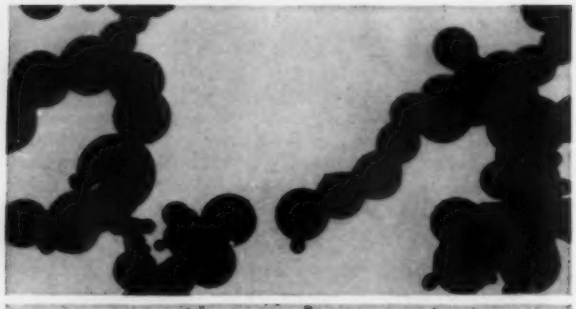


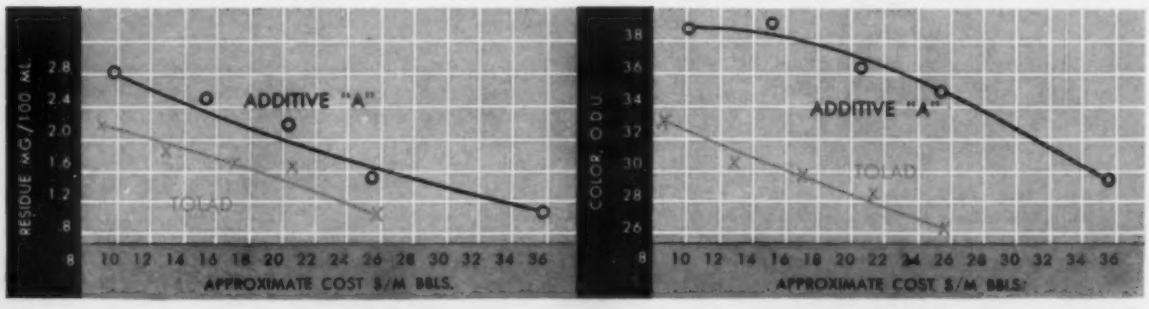
Above photomicrographs (magnification 6000X) show fuel oil samples after 12-week oven storage test. The upper photo is of a sample containing no additive, the lower sample photo contains TOLAD at commercial concentration. Note the fine particle dispersion attained by TOLAD Fuel Additive.

The use of TOLAD* Fuel Additive, by preventing deterioration of fuels in storage, enhances marketability and reduces customer complaints. TOLAD Fuel Additive prevents the formation of sludge and insoluble residue, the causes of fuel plugging in fuel lines, filters and burner tips. Insoluble residue also is a primary problem in diesel engine operation, causing fouling in fuel injection systems.

While TOLAD Fuel Additive is just being announced, it has been under laboratory test for over five years, and under controlled commercial testing for two years. As a result of these commercial use tests, six different refiners now use TOLAD on a routine basis. TOLAD Fuel Additive has been approved for use in diesel engine fuel by leading railroads.

One of the most important advantages of TOLAD Fuel Additive is its low cost. In two years of commercial use tests, TOLAD not only provided comparable *or improved* fuel stability for the fuels tested, but it consistently did so at a substantial cost advantage over the additive it replaced.

The graphs below illustrate the economic advantages of TOLAD over a well-known commercial additive. On fuel samples stored for 12 weeks at 110° F, the TOLAD-protected fuels showed less residue and better color, and always at a lower cost.



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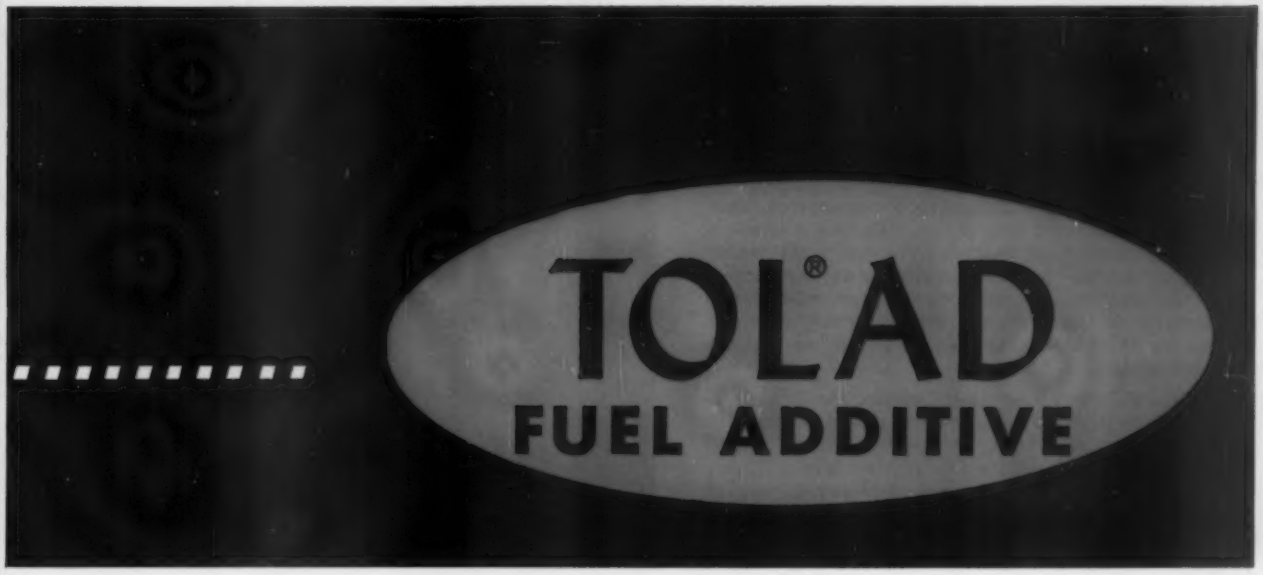

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as valves and spectacle blinds or double blocks and bleeds against catalyst containing vessels, such as in reformers or poly plants, where catalyst can be regenerated or replaced without shutting down. Likewise, isolating valves are frequently placed at tanks and accumulators, containing large volumes of material. In this way, the danger of releasing large quantities of hazardous material through line breaks is averted.

Flow sheets can be examined, to see that emergency dump valves are provided properly at furnaces. Also, a check is made for snuffing steam to the fire box and to the header box compartments. With steam, or other utility connections to hydrocarbon lines, it is a good safety practice to provide check valves or other means of preventing the backup of oil into the utility system, should that system lose pressure for some reason.

Examine the utility flow sheets carefully too. In particular, both firewater and steam systems should be made as reliable as practicable, owing to their importance for fire protection. Generally both these systems are looped, so that pressure can be supplied, to either end of any segment of the loop. For this to be of value, in the event of damage to a portion of the system, isolating valves must be located properly and in sufficient number. In this way, a good portion of the system can still be used, in spite of damage to part of it.

A good deal of attention is given to sampling points in a flow sheet review. First try, insofar as possible, to select a location where there is the least hazard from temperature or pressure. For example, it is just as convenient to sample at a pump suction, rather than a pump discharge, and much safer from a pressure standpoint. Where it is unavoidable to take a sample at high temperature, a small cooler is added to lower the sample temperature and reduce the hazard to the operator. In the case of gas samples, two connections are used — one to the sampling point and one to a safe vent. In this way, the sampling container can be purged and a representative gas sample obtained, without the hazard of allowing light material to flow freely to atmosphere.

Before leaving the subject of flow sheet review, it should be emphasized once again that here is an extremely important area to apply the principles of safety, when engineering a new facility.

Sohio's manufacturing department safety committee reviewing design drawings. Pictured from left to right are: Les Mills, Everette Kerns, and Jack Rover.

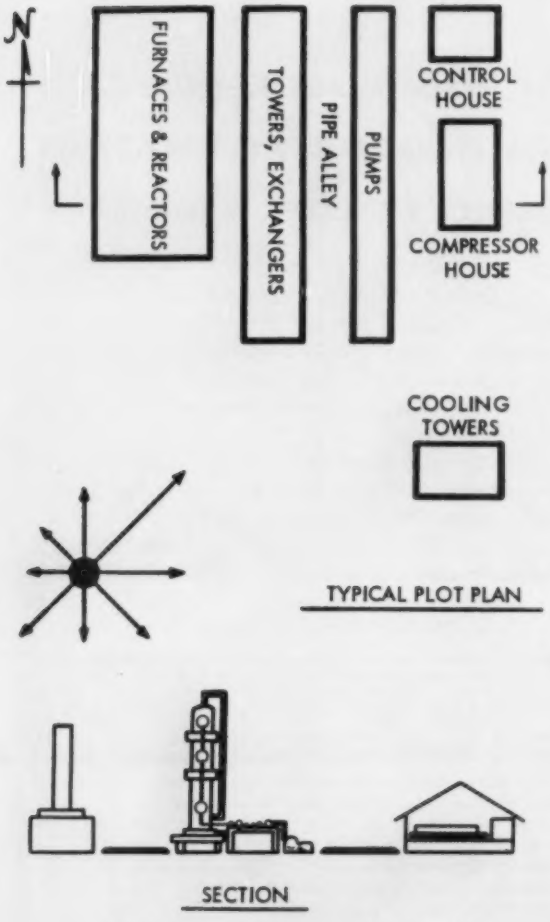

FIG. 1. Typical reforming unit plot plan.

PLOT PLAN

The next and equally important area, where safety plays a big role, is in developing a plot plan for the plant. In the majority of cases, the unit being designed will be located in an existing refinery, so the first step is to select the proper location within the refinery. Of course there are many things to be considered, in addition to safety — proximity to shops and warehouse, road and rail accessibility, long range master plans for the entire refinery and so on. But while considering these, never lose sight of the fact that safety is one very important consideration. The unit should be located away from major tankfields, because of the obvious hazard they represent to the unit and vice versa. The area should also be a reasonable distance from other operating units, which might be undergoing maintenance shutdowns, at times other than the new unit under consideration. Of course, state or local ordinances usually dictate minimum distances to property lines, public roadways, etc.

Above all, the area considered should be big enough for the unit. A congested plot plan reduces the safety level significantly both during operation and during shutdown maintenance. Additionally maintenance costs are likely to suffer.

In choosing the best site for a new unit all the possible

alternates are considered before establishing the exact location within the plant. At Sohio, this decision must be reviewed by the Manufacturing Department Safety Committee. This committee is composed of three men, whose combined operating and engineering experience in refinery work totals nearly 80 years. And many of these years have been devoted exclusively to safety work or closely allied activity. This committee reviews new plant designs, at specific stages of work, and at other times as they are called upon for assistance. The review of the chosen site location is the first specific approval required of this safety committee, during the course of engineering the new unit.

The next consideration once the site is chosen is locating the equipment in the plot. Fig. 1, a typical reforming unit plot plan can be used to illustrate safety considerations in equipment location.

Prevailing wind is from the southwest quadrant. Note that the furnaces are upwind of other equipment. This means that, most of the time, any heavier-than-air hydrocarbons which might be released are carried away from, not into the furnaces. This reduces the danger of gas accumulations being ignited from that cause. Note too that the clouds of water vapor, which issued from the cooling tower, will usually not be carried into the operating area to limit visibility.

Clear space is provided between the furnace-reactor area and the tower-exchange area. This serves two purposes. First, from a safety standpoint, it isolates groups of equipment, reducing the hazard of each to the other. Second, it affords clear access for emergency vehicles and during turnaround maintenance.

Both of these areas are paved and the tower-exchanger area depressed about eight inches below surrounding grade. Thus, any spills occurring in this area are contained and, except in a very extreme case, will not become a hazard to adjacent areas. The pump row is similarly paved and depressed.

The pump row is convenient to the access road just east and, during operation, pumps requiring repair can be worked on in place or lifted out, with minimum danger to nearby equipment. This arrangement is far less hazardous than others, which locate pumps in with towers and exchangers or under pipe banks. Note that this road along the pump row can also be used for emergency equipment. Thus, there is clear access to both sides of the bulk of the processing equipment in the event of fire. Here too, the roadway serves to some extent as a firebreak, between the tower-exchanger-pump group and the compressor house.

The control room . . . This may not be the ideal place for it. On the center of the North or East sides would have been better, from the standpoint of being a more central location. However, it is on the perimeter of the plot, permitting a safe means of escape for the operator, should this be necessary. Also, it is somewhat separated from operating equipment and in less danger from fire or explosion.

In reviewing a plot plan, **tentative** locations should be established for such things as firewater hydrants, hose reels, fire steam hoses, safety showers, emergency depressuring valve operators and snuffing steam manifolds. The word **tentative** should be stressed. The specific locations for these are more satisfactorily done on a model.

If the unit requires railroad service, the plot plan should be examined for proper clearances for the safety of the rail crew. It is wise also, to keep critical pieces of equipment away from the end of a spur, should the engine operator have slow reflexes!

A final word on plot plans. Try, as far as possible, to anticipate any future equipment which may be required in the unit and leave real estate for it. This has an unnoticeable effect on initial investment costs and permits the future installation to be made without overcrowding and incurring the hazard associated with this congestion.

MODEL REVIEW

Models have been found extremely valuable, not only in reviewing the detailed design of a plant, but also in operator training and in getting a finished job with far fewer safety hazards. Most people have difficulty visualizing in three dimensions, from a drawing in two dimensions. Consequently, without the aid of a model, these safety hazards often remain undiscovered, until the plant is too far along in construction. Then, the pressure of an early startup date or the high cost of a field modification, prohibit the correction of all but the very serious hazards. A scale model of the plant, ¼ in. or ⅜ in. to the foot, aids in finding these safety hazards and correcting them before the design is too far along and construction has started.

To be most useful for this purpose though, the model must be quite detailed and accurate and it must be completed quickly. There are many things a close review of the model will find. First, accessibility. It is possible to see whether all instruments and frequently-operated valves can be reached from grade or ladder or platform. This means a great reduction in the use of temporary scaffolding or ladders or even more impromptu devices and a corresponding reduction in the possibility of injuries by falling. It is possible to spot valve stems, projecting into aisles that might cause various injuries. It is possible to see whether handling facilities have been properly located, to service relief valves, exchanger parts, tower internals, etc. And one can make sure there is a clear area at grade below these devices, to land the material.

A model can be used to locate building doors properly, so that exits are on different sides and, if possible, away from a potential source of fire or explosion.

Earlier mention was made of **tentative** locations for emergency equipment on the plot plan. On the model they can be *exactly* located, with the added convenience that three dimensions give. Snuffing steam manifolds can be spotted in a location that is protected from a fire at the furnace. Hand wheels for emergency valves can be located where the operator has a clear access to them and a clear escape route away from them. Fire hose reels, hydrants and monitors can be placed in such a way as to be unobstructed by columns, piping, or similar interferences.

All operating platforms should be checked to see that there is more than one means of descent, should that one be blocked. It is possible to see that the provisions for fireproofing structures and equipment supports are sufficient, both as to items protected and height of protection. The lines on the model can be color coded, to indicate the extent of insulation. Thus, it is possible to check for proper protection to personnel at grade and on platforms from the hazard of burns by hot lines. Even such a small item as the point of discharge of a steam trap can be checked, should the model be sufficiently detailed, and corrected, if it constitutes a safety hazard.

The safety committee, mentioned earlier, makes another review of the engineering work at this point in the design phase of the job. They examine the completed model with great care and recommend changes be made, which — in the background of experience which they possess — are needed to avoid accidents and injury to operators or maintenance crews. In particular, they examine the location of the fire protection facilities — hydrants — hose reels — extinguishers — fire steam connections and safety showers.

Engineering scale models are extremely useful tools, in designing hazards out of a plant, before construction be-

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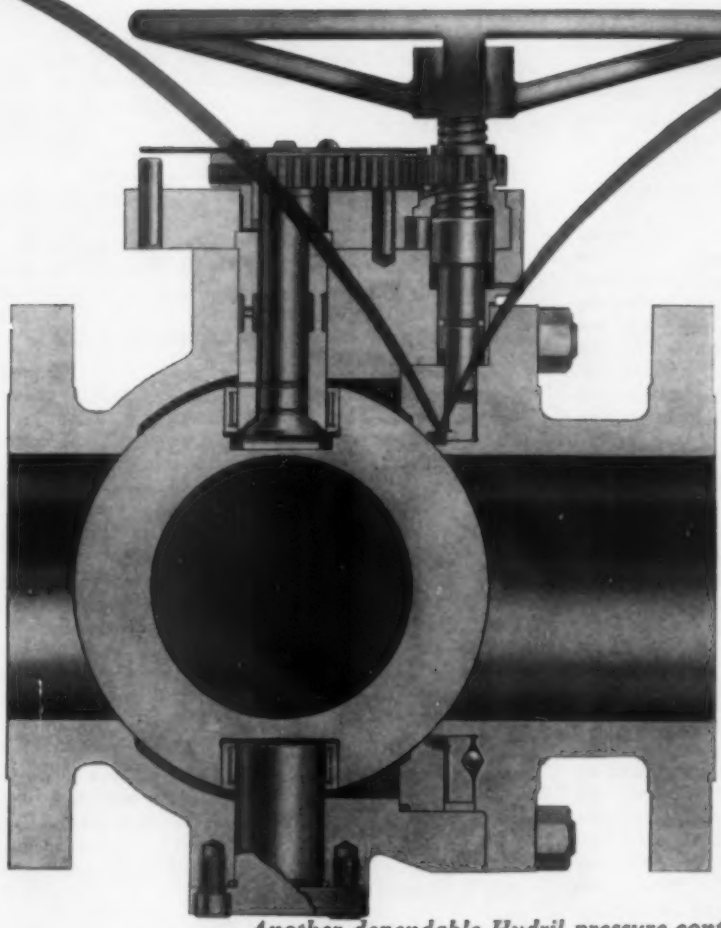

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gins, thus making it possible to get a safer unit with a minimum of extra costs for field modification.

CONSTRUCTION INSPECTION

Safety is involved in the construction phase of a project in three different ways. The work itself must be performed safely, the completed construction must be of such quality as to be safe to operate, and construction work must be done in a manner so as to present the least hazard to existing operating units in the refinery.

Using a contractor experienced in refinery construction contributes much to overall safety. He will be aware of the special hazards attendant to this type of work even before he begins. In addition, Sohio makes it a practice to include in inquiries to contractors a formal writeup of **"Safety Rules and Instructions for Contractors and Their Employees,"** and these rules are also incorporated into the construction contract. These safety rules include the same plant rules and regulations which govern the work of refinery employees as well as rules applicable only to contractor employees. They forbid contractors' men to operate any refinery equipment, turn any valve, enter any part of the refinery not designated a construction area, and lay down very complete instructions on how to proceed with "hot work." The rules finally give the contractors' employees instructions, as to reporting fires and accidents attendant to construction activity and warn them to keep far away from any fires or accidents elsewhere in the refinery.

Inspectors . . . Our company usually assigns one or more construction inspectors to the job site, to work with the contractor. Part of his job is to see that the contractor and his employees follow the safety rules, under which the work is to be done: that they barricade and set lights at open excavations, that they observe safe speed limits within the refinery, that they allow smoking only in posted areas, and so on. Another of his important functions is to see that the quality of workmanship produces a sound, finished job. During the course of the work, the inspector conducts tests on concrete, witnesses hydrostatic tests of pressured systems, and a very important part of the job is weld inspection.

General specifications on electrical work establish the minimum illumination level required for safe working conditions around the processing equipment—and, in particular, at stairways, ladders, and platforms. At night, near the end of the job and after all lighting has been installed, the inspector surveys the entire job with a light meter, seeking out areas which are inadequately illuminated. This work forms the basis on which lighting is added, to bring the intensity to the minimum safe level.

Work of the inspector, in maintaining construction quality, cannot be stressed too highly. His is the "last chance," so to speak, to uncover flaws that might endanger the safety of the facilities and correct them before beginning operation.

The third function of the inspector is that of providing liaison between the contractor's construction work and refinery operations. For example, he will not permit the contractor to open a ditch across a road in the refinery, until satisfied that there are alternate routes available for emergency equipment, to reach anywhere in the refinery. He arranges for hot work permits to be given for cutting, welding, grinding, etc., in areas close to operating equipment or in tankfields. And he sees that the refinery fire inspector has checked the area for safety, before the permit is issued.

In almost any new work there are tie-ins to be made with existing lines or equipment. The inspector watches this work especially. It must be done with great care in order not to endanger the workers themselves or the equipment to which the tie-in is being made. Good practice dictates blanking these tie-ins during the remaining construction period and until startup.

One last point on inspection of construction — the safety committee mentioned before, takes still another look at the job, this time near the end of construction. And once again, if they see things which must be corrected, to obtain adequate safety, they are pointed out for correction. Rarely is a major one required, as a result of this review. Having already examined the plot plan and model, the sort of thing usually found by the committee at this time are tripping hazards – head bumpers — and shin crackers.

PRESTARTUP OPERATOR TRAINING

Long before construction is completed, operating people have participated in the work. Earlier their help in reviewing flow sheets, examining the model, and helping with plot plan studies were mentioned. Near the end of construction, their work begins in earnest. A big job still remains, that of training supervisors and operators to operate the equipment in a safe and efficient manner. This requires a thorough knowledge of the potential hazards, proper organization to meet any emergency, and training in the use of safety and fire fighting equipment.

The chief safety man in Sohio refineries is the Plant Manager. He delegates much of his authority for safety to the line organization, but he is always accountable. Safety is a line job — not staff. The Safety Engineer at each refinery assists the line organization in carrying out their function and acts as a catalyst in generating interest and enthusiasm in supervisors for carrying out a safety program.

When building a new unit, a concentrated training program for the supervisors and operators is conducted. At the beginning of the training program, the supervisors are the pupils and become thoroughly familiar with the design and operation of the unit they are soon to operate — later the supervisors become the teachers and the operators the pupils. This gives the supervisor a good check on how well he has learned his unit.

One major training aid is an operator training manual. Since safety must always be a fundamental part of training it should be included as part of the operating instructions in this manual. Operators must not feel that safety is one thing and operations another. Thus, in training sessions for either supervisors or operators on any particular part of the unit, the potential hazards and safety precautions are discussed right along with the other operating details.

A training program often includes frequent field trips, first to the scale model, and later to the actual equipment. Here, the operators trace lines, look for hazards, and go through the motions of starting and stopping equipment. They also learn how to operate various types of safety and firefighting equipment attached to the unit and surrounding area.

The design engineer has a grave responsibility for the safety of others in his work of designing new refining facilities. He must be constantly aware of this responsibility from the beginning of the job to the end. And, he must review the work every step of the way, checking and rechecking, to make sure that the finished job is adequately safe in all respects. ★ ★ ★

Mr. Graham *was a 1938 graduate in Mechanical Engineering from Case Institute of Technology. Started engineering career with Babcock & Wilcox Co. After military service with Air Force in Meteorology joined Sohio in 1946. Has been in Sohio's General Engineering Division throughout. Present job, Supervisor, Engineering Service Section.*

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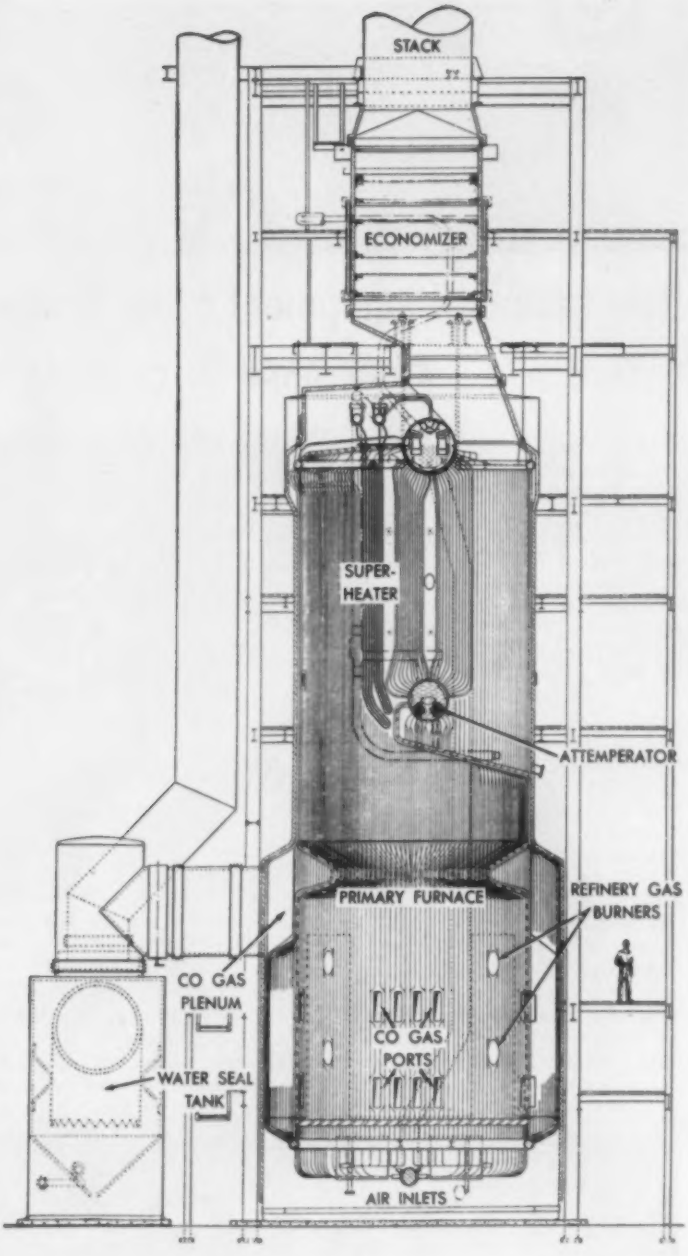

CO-104

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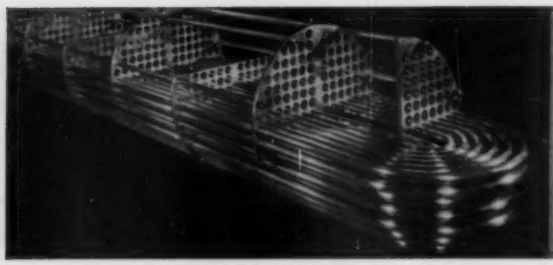

CONDENSER AND HEAT EXCHANGER CLINIC

Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, New York

New tube mill equipment gives designer of heat-transfer units freer hand in meeting new trends

With the installation of new production and testing equipment, The American Brass Company now offers the most complete service available to users of condenser and heat exchanger tubes.

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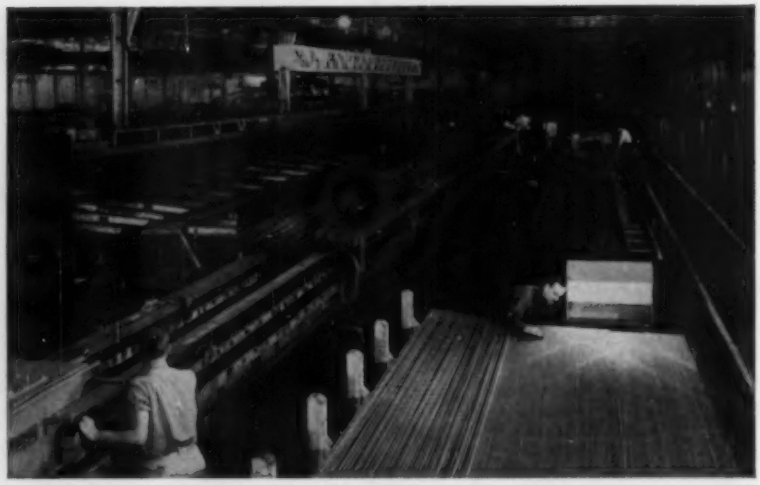

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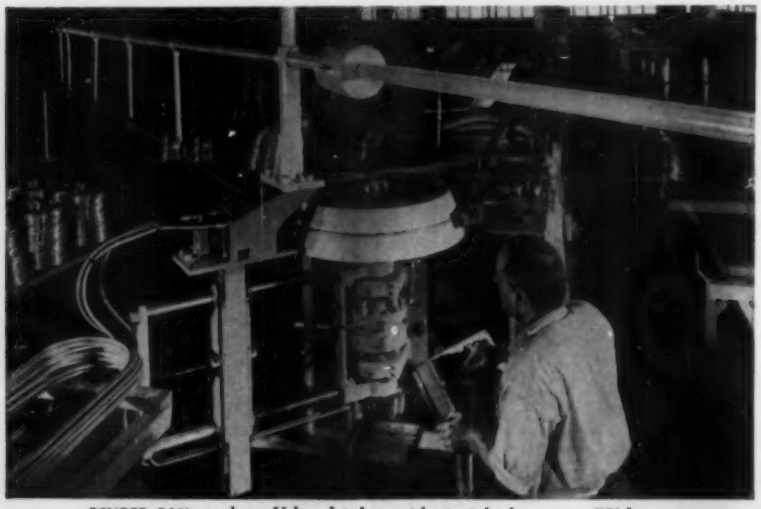

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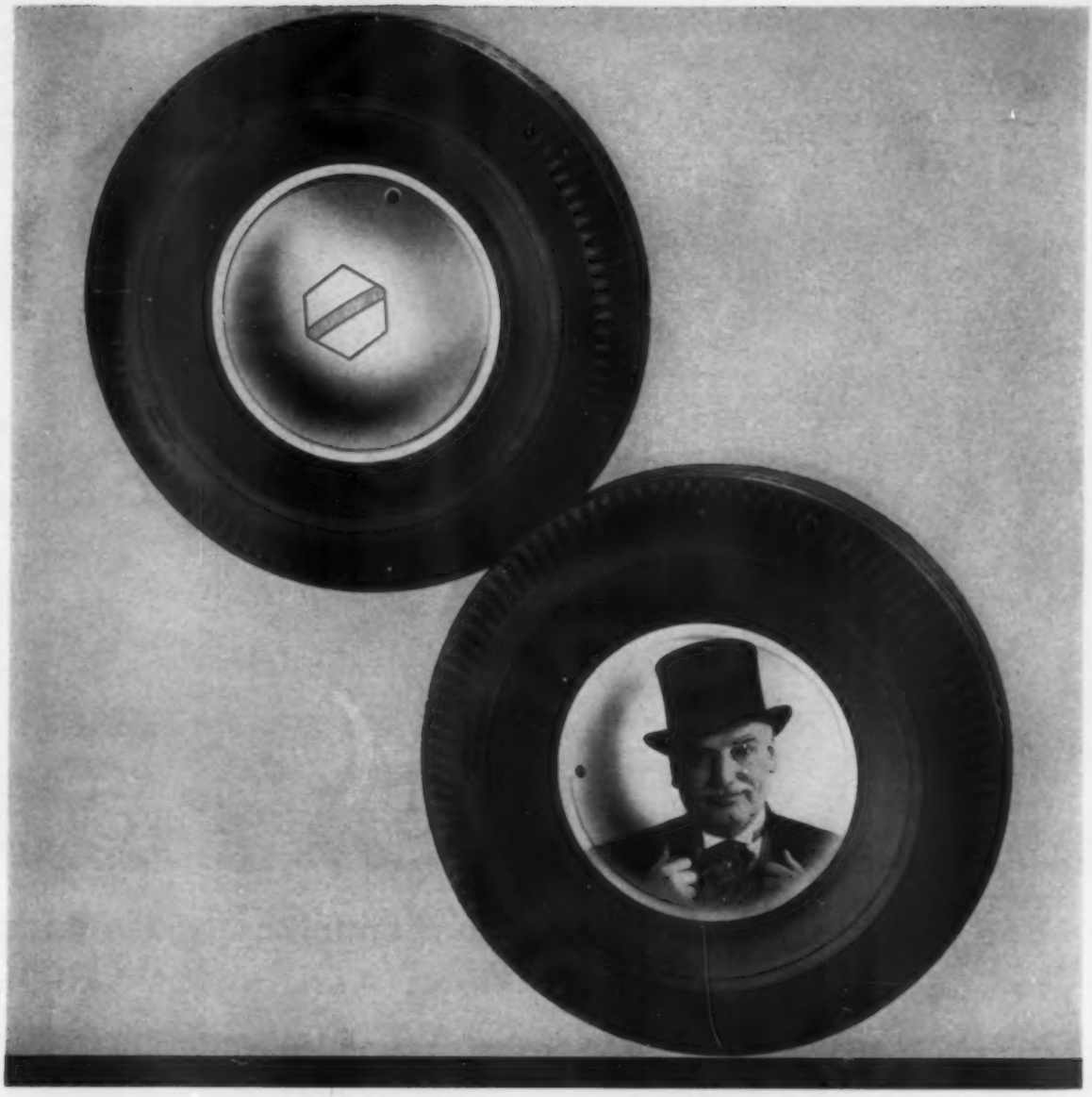

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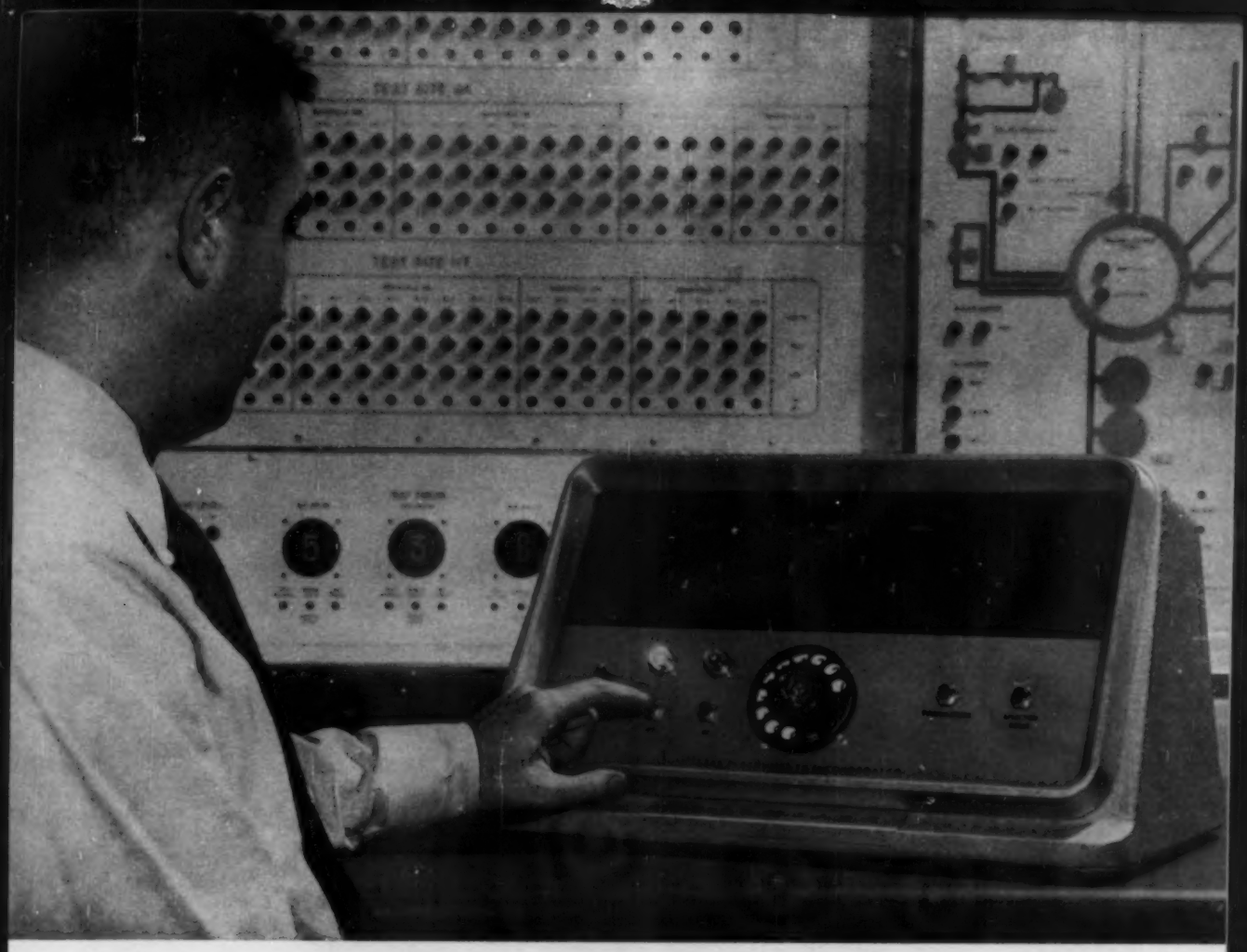

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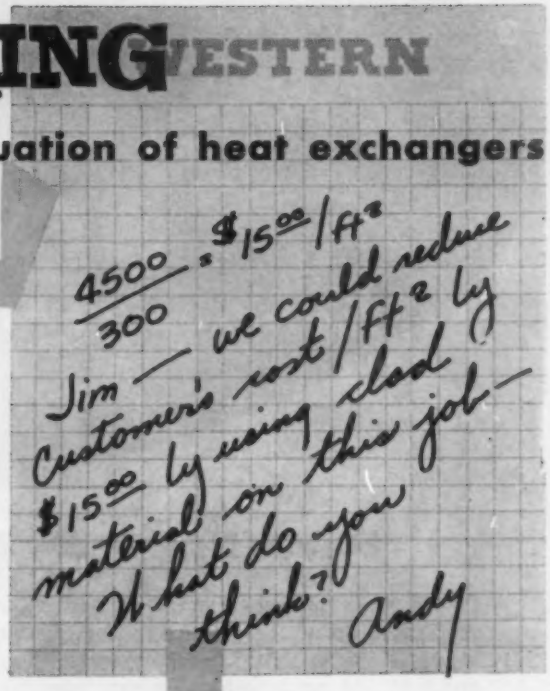
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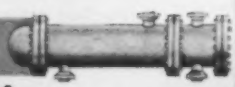

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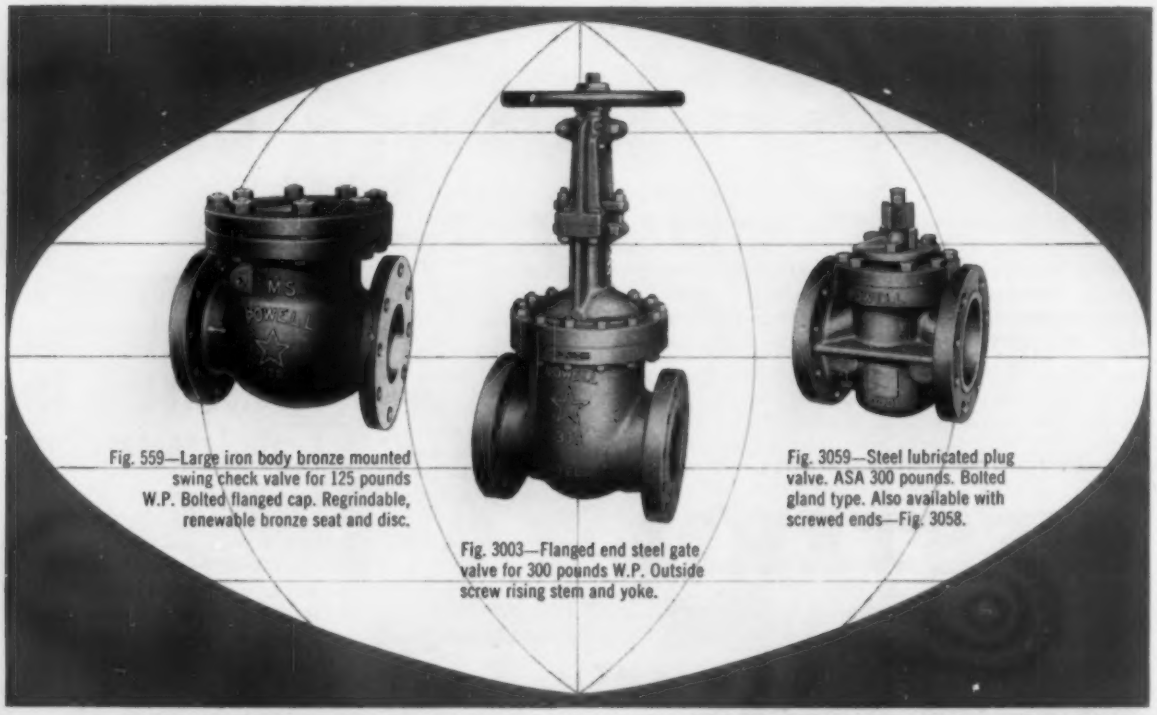

Fig. 559—Large iron body bronze mounted swing check valve for 125 pounds W.P. Bolted flanged cap. Regrindable, renewable bronze seat and disc.

Fig. 3003—Flanged end steel gate valve for 300 pounds W.P. Outside screw rising stem and yoke.

Fig. 3059—Steel lubricated plug valve. ASA 300 pounds. Bolted gland type. Also available with screwed ends—Fig. 3058.

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DU PONT *Petroleum Chemicals* NEWS

Number 101 in a Series of Bulletins for the Petroleum Industry

MARCH-APRIL 1960

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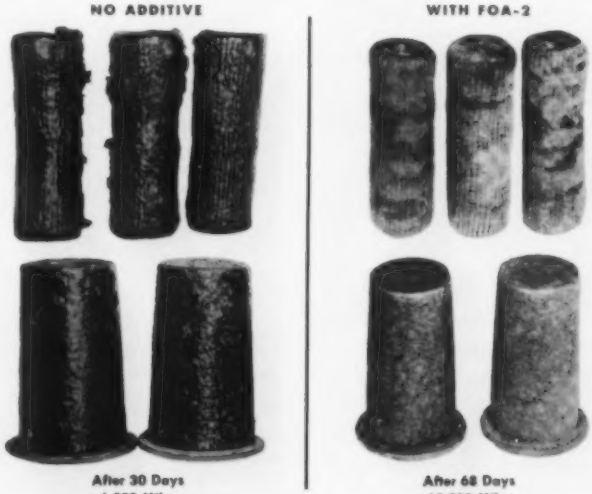
The four folders are concerned with those who worry about their tires, oil and oil changes, lube jobs, and lastly, the multiple worries of women. Each contains tips on how to put those worries to rest. The theory behind it all being that "If you save them worry . . . they'll save their business for you."

Refiners, large and small users, all enjoy savings

Du Pont Fuel Oil Additive No. 2 provides a wide range of benefits for refiners, distributors and users. It ends the multiplying costs of sludge and gum formations which penalize everyone. Simple and economical to use, it is effective throughout the whole range of distillate fuels. Refiners have found the benefits of FOA-2 more than pay for the cost of addition.

FIGURE 10
FOA-2 RETARDS FILTER PLUGGING IN DIESEL LOCOMOTIVES



In the refinery

FOA-2 added to catalytic cracked fuel oils produces a stable product, at a fraction of the cost of other means.

It can be used to overcome incompatibility that may be encountered when blending catalytically-cracked and straight-run fuel oils.

Added to residual fuels *before* they go into storage, FOA-2 will reduce or prevent costly mechanical cleaning of storage facilities. The product may also be used gradually to disperse sludge which may already be present.

CONTINUED OTHER SIDE

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT *Petroleum Chemicals* NEWS

CONTINUED **FOA-2**

Fuel Oil Customers

It has been found that FOA-2 effects a major reduction in home heating service calls. It minimizes oil burner ignition failures . . . keeps the oil free-flowing and clean burning . . . ends sludge formation in tanks, filters and nozzles. Being a nonmetallic *ashless* additive, it does not leave ash deposits to foul operation of the stack controls or ignition system.

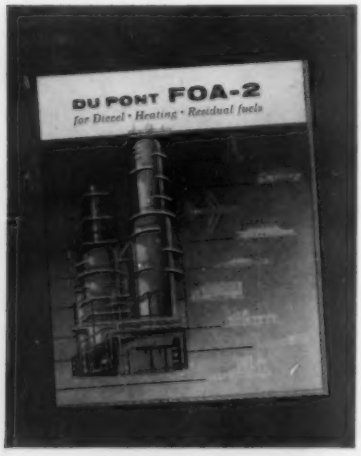
In storage, stocks accumulated during the summer remain satisfactory for winter consumption.

Users of residual fuels find that FOA-2 keeps their fuel storage and supply systems clean and burners operating smoothly.

Diesel Operators

Railroads and other large users of diesel fuels appreciate the economy of cracked distillates stabilized with FOA-2. Filterability is improved and injector sticking problems are reduced.

Being a nonmetallic additive, it does not add to the exhaust stack sparking problem.



FOA-2 with DMD

Pre-mixed combinations of FOA-2 and Du Pont Metal Deactivator are widely used. FOA-208 contains 8% DMD while FOA-212 contains 12% DMD.

A 24-page brochure on FOA-2 with information on properties, concentrations, handling, uses, etc., is available.

Your Petroleum Chemicals Representative will be glad to furnish you with copies of this brochure as well as additional technical information and samples for use with your own stocks, or write Petroleum Chemicals Division in Wilmington.

Golden Gate Office gets new manager

JAMES G. McILHINEY, a veteran with a diversified background in the Petroleum Chemicals Division, and a San Francisco sales representative for more than a year, is now Manager of the San Francisco District.

In his twelve years with Du Pont, Mr. McIlhiney has worked closely with many oil companies in a wide variety of marketing, technical and safety areas. He brings to his present post a thorough knowledge of conditions and needs in the field.

Born in Jersey City, N. J., he went to Cornell University, graduating in 1935 with a degree in Mechanical Engineering. Before joining Du Pont he was associated with Air Reduction Sales Company as a sales representative and engineering specialist.

With Du Pont he has been a sales service representative in the Eastern and Gulf Coast regions. In 1955 he was assigned to the division's technical group in Wilmington, Delaware. He also represented the Petroleum Chemicals Division in the Mid-Continent Region where he remained until early in 1957. Since then he has been a familiar figure in the bay area refineries.

High effectiveness at low concentrations characterizes "Ortholeum" 302 Antioxidant

New Du Pont "Ortholeum" 302 antioxidant has proved, in laboratory evaluations, to be more highly effective at considerably lower concentrations than other currently-used oxidation inhibitors.

A general purpose ashless antioxidant, it is effective as a stabilizer for greases, turbine oils, crankcase oils and synthetic lubricants.

Tests have shown that "Ortholeum" 302 frequently will provide stability for greases which fail to respond to normal concentrations of conventional antioxidants.

In turbine oils concentrations as low as 0.05 to 0.10% by weight are often more effective than higher concentrations of other antioxidants.

Tests have also suggested that "Ortholeum" 302 may prove useful as an auxiliary additive to other antioxidants in crankcase oils. Experiments with a concentration of 0.25 weight per cent in a 400 SUS solvent extracted neutral oil indicated that it did an excellent job minimizing bearing corrosion in a double-length L-4 Chevrolet engine test.

In some synthetic oils, "Ortholeum" 302 frequently exceeds the performance of widely accepted synthetic oil antioxidants in controlling viscosity changes, copper corrosion, and acid number when the oils are subjected to high-temperature oxidation tests.

Your Du Pont Petroleum Chemicals Division representative will be glad to supply more information and samples.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. . . . . RAndolph 6-8630
Cleveland 15—101 Prospect Ave. . . . . MAin 1-3422
Houston 2—
705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 4-1354
New York 20—
45 Rockefeller Plaza . . . . . COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza . LOcust 8-3531
Pittsburgh 22—1 Gateway Center . . . . ATlantic 1-2933
San Francisco 4—111 Sutter St. . . . . EXbrook 2-1934
Seattle 3—4003 Aurora Ave. . . . . MElrose 2-6977
Tulsa 1—1811 So. Baltimore Ave. . . . . LUther 5-5578
In Canada—Du Pont of Canada Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12,** Ontario . . . . . HUdson 1-6461
OTHER COUNTRIES:
Petroleum Chemicals Division, Export Sales, Wilmington 98, Delaware . . . . . PRospect 4-2962

DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

Du Pont Tetraethyl Lead and other Petroleum Additives

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-13616

Printed in U.S.A.

CHECKUP on your Control Valves... CHECKOFF these Annin Advantages*

*Any other source might give you a few... but with Annin you get them all!

MINIMUM number of parts per complete valve.

OVER 60,000 successful case histories of split body valve applications.

POSITIONING ACCURACY guaranteed, .001 inch per inch of stroke.

CONSTANT INSTRUMENT signal sensitivity throughout signal range.

COMPLETE INTERCHANGEABILITY of any Domotor valve to on-off pneumatic control, pneumatic hydraulic, electro hydraulic, electro pneumatic or manual actuator.

ENGINEERED FOR MANUAL control with any of the above automatic actuators, if desired, at minimum cost.

SIMPLIFIED ADDITION of high speed booster units to any pneumatic positioning actuator.

ADAPTABILITY of bellows seal, doolseal or plain extension to any standard valve.

BODY SIZES from ¼" up.

COMPLETE LINE of body ratings: 600—1500—2500 lbs. ASA; special 10,000 and 60,000 psig design, temp. —450°F to 1600°F.

CONVERSION FROM globe body to angle body construction with only one additional part.

ADAPTABILITY TO 3-WAY Valve Construction with minimum parts and cost.

MINIMUM COST for change from soft seat construction to hard seat, or vice versa.

First in a series of checklists on Annin features.

Annin VALVES

THE ANNIN COMPANY
1040 South Vail Avenue
Montebello, California

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

The 20th Century Genie

HARSHAW FLUORIDES

Harshaw first started to manufacture hydrofluoric acid in 1904. Today, Harshaw's Fluoride Division produces 26 different fluoride chemicals for as many industries.

In addition to

BORON TRIFLUORIDE

HYDROFLUORIC ACID—Aqueous-Anhydrous

there is a long list of other fluoride chemicals. If necessary, you are invited to draw on the experience of our staff of technical specialists.

THE HARSHAW CHEMICAL CO.

1945 East 97th Street • Cleveland 6, Ohio

Chicago • Cincinnati • Cleveland • Detroit • Hastings-On-Hudson
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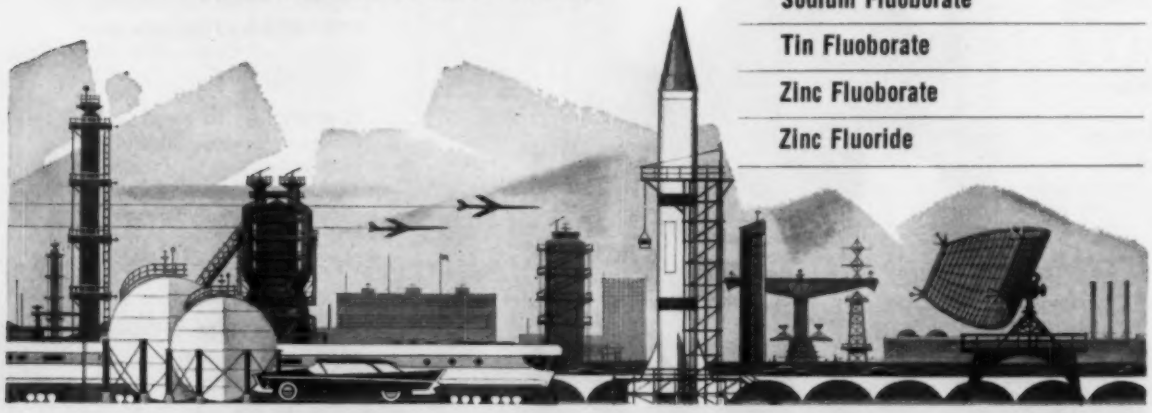
HARSHAW ALSO SUPPLIES:

- Ammonium Bifluoride
- Ammonium Fluoborate
- Barium Fluoride
- Bismuth Fluoride
- Boron Trifluoride
- Boron Trifluoride Complexes
- Chromium Fluoride
- Copper Fluoborate
- Fluoboric Acid
- Fluorinating Agents
- Frosting Mixtures
- Hydrofluoric Acid Anhydrous
- Hydrofluoric Acid Aqueous
- Hydrofluosilicic Acid
- Laboratory Fluorine Cells
- Lead Fluoborate
- Lithium Fluoride
- Metallic Fluoborates
- Potassium Bifluoride
- Potassium Chromium Fluoride
- Potassium Fluoborate
- Potassium Fluoride
- Potassium Titanium Fluoride
- Silico Fluorides
- Silicon Tetrafluoride
- Sodium Fluoborate
- Tin Fluoborate
- Zinc Fluoborate
- Zinc Fluoride



with Davison Catalysts

Your stack carries away regeneration gases —not catalyst—when you put Davison in your unit. Here's why:

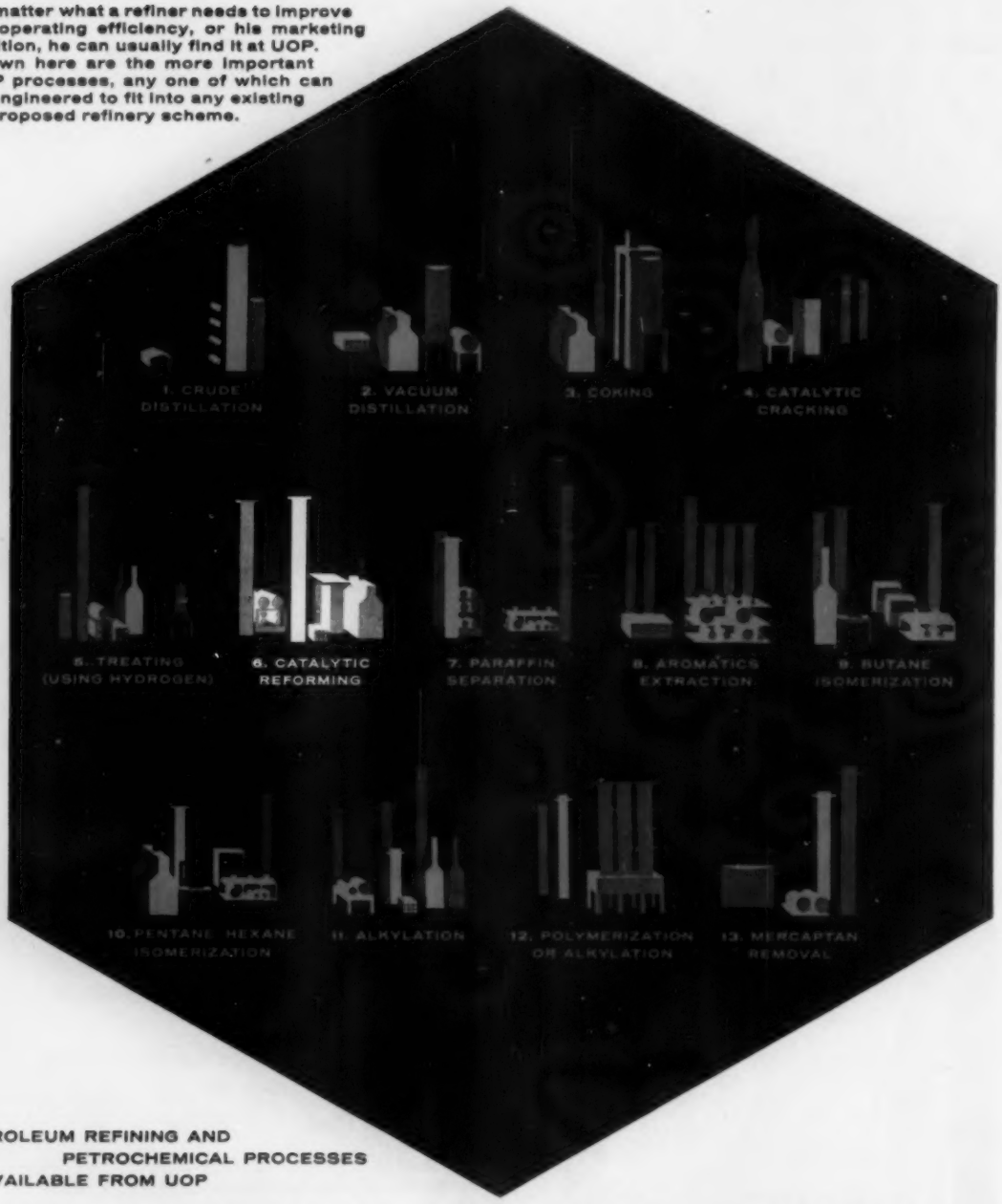
With Davison Catalysts you get the lowest amount of unretainable fines.

With Davison Catalysts you get lower attrition. The lower breakdown rate of Davison Catalysts means you get the fines you need without light particles escaping up the stack.

The reason: *balanced density*. There's a Davison Catalyst to suit your application. Write Department 421P, today for Product Service Bulletin No. 59-101.

W.R. GRACE & CO.
DAVISON CHEMICAL DIVISION
BALTIMORE 3, MARYLAND

No matter what a refiner needs to improve his operating efficiency, or his marketing position, he can usually find it at UOP. Shown here are the more important UOP processes, any one of which can be engineered to fit into any existing or proposed refinery scheme.



PETROLEUM REFINING AND PETROCHEMICAL PROCESSES AVAILABLE FROM UOP

1. **CRUDE DISTILLATION** equipment is designed and engineered by UOP in any desired capacity.

2. **VACUUM DISTILLATION** and **VISBREAKING**—easy-to-operate processes for preparation of feed stocks for catalytic cracking.

3. **L.P. COKING** permits adjustment of gasoline-to-heavy oils production ratio to meet market needs.

4. **FLUID CATALYTIC CRACKING**—an improved process that gives higher yields, higher octane numbers.

5. **UNIFINING™**—a modern process that completely purifies petroleum distillates.

6. **PLATFORMING®** produces high octane gasolines, high purity aromatics.

7. **MOLEX™**—a new continuous separating process that removes lowest-grade hydrocarbons from gasoline.

8. **UDEX®**—the ideal process for separation of super-purity aromatics.

9. **BUTAMER™**—a new and practical process for producing isobutane.

10. **PENEX®**—a new process that converts light, normal paraffins to isoparaffins.

11. **HF ALKYLATION**—makes alkylate, top anti-rumble motor fuel. Sulfuric acid process also available.

12. **CATALYTIC CONDENSATION**—converts olefin fractions of refinery gases into high-quality gasoline and petrochemicals.

13. **MEROX™**—a new and inexpensive treating process to remove mercaptans from gasolines and light distillates.

PROCESSES NOT ILLUSTRATED:

REXFORMING®—the ideal process to insure your top octane position.

CATALYTIC DEHYDROGENATION—removes hydrogen from hydrocarbons to produce less-saturated hydrocarbons.

HYDEAL™—a new process for the hydrodealkylation of toluene or C_9 aromatics to produce benzene; may also be used for manufacturing phenol and naphthalene.

HYDRAR™—converts benzene to cyclohexane with excellent yields, achieves extreme high purity with Udex grade benzene.

OLEFIN EXTRACTION—efficiently separates olefins and diolefins from paraffins; prepares olefins for further conversion.

AROSORB™—removes heavier aromatics from synthetic and natural distillates, produces aromatic-free heavier distillates.

ALKAR™—produces ethylbenzene, cumene and other alkylated aromatics from Fluid Cat Cracker off-gas streams.

UNISOL®—an economical process for treating high mercaptan-containing gasolines.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

*'62 COULD BE THE YEAR FOR YOU!

why motorists want higher gasoline quality

Refiners right now have adequate crude capacity, but intermediate and final product processing facilities are still inadequate. Demand for higher quality in gasolines is still growing—and could put refiners in short supply within two years.

Here then, lies opportunity. Manufacturing a larger ratio of higher quality products can raise a refinery operation to new levels of profit.

What will this involve? That depends on existing process facilities, sources of crude supply, actual and potential markets, price levels and other factors.

In all of these areas Universal can provide outstanding service. UOP research and service facilities, know-how, accumulated technical and market data and specialized experience are brought to bear on every facet of the problem—*and there is a UOP process to meet any refinery need.*

Start now to determine the best way to capitalize present and future marketing opportunities.

*THE CONSENSUS OF INFORMED OPINION is that 1962 will require a substantial increase in process capacity . . . NOW is the time to start your planning!

UOP

UNIVERSAL OIL PRODUCTS COMPANY

20 Algonquin Road, Des Plaines, Illinois, U. S. A.

WHERE RESEARCH TODAY MEANS PROGRESS TOMORROW

PLATFORMING®

One of the most widely used processes in the refining industry, Platforming is the practical and economical method for upgrading gasolines. Originated and developed by UOP, this process is inexpensive to install, reliable and easy to operate. The platinum-containing catalyst is highly active and hence provides truly continuous operation. Costs of periodic shutdowns are considerably reduced and initial cost is lower due to the lack of necessity for expensive regeneration equipment. Platforming can handle the full boiling range gasolines without prefractionation, or naphtha cuts separated from them. It is also highly efficient for producing aromatics such as benzene, toluene and xylenes.

HUMBLE COREXIT

Save time and money previously lost to internal corrosion: use Humble COREXIT . . . COREXIT effectively and economically prevents internal corrosion in pipe still overhead, distillation towers, vapor recovery systems and other refining units. COREXIT will reduce or completely eliminate plugging or fouling. This protection against sludge, scale and corrosion cuts non-productive downtime to a minimum. For complete information on technical services and products, contact your Humble salesman.

HUMBLE

HUMBLE OIL & REFINING COMPANY

How B&W JOB-MATCHED TUBING solves any stainless pressure tubing problem

When you call on B&W for your stainless tubing requirements you can get:

- . . . extra-long tubes (even 90-foot,* for example) if they are most suitable for your installation
- . . . a wide range of stainless analyses permitting a choice of the one grade best for your job
- . . . uniform mechanical properties and dimensions for ease of bending, welding or other fabrication

*manufactured by welding to obtain length

These are just a few of the reasons it pays to specify B&W Job-Matched Stainless Steel Tubing. Call your local B&W District Sales Specialist, or write for Bulletin TB-355 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-9020-S4

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

MANNESMANN

The Mannesmann product list for the oil industry includes the following items

New Literature

Attack Mechanisms . . . water conditioning data sheet, entitled, "How Corrosion Attacks Industrial Water Systems," explains how boiler, cooling and process water systems are constantly plagued by corrosion. *Betz Laboratories, Inc.*
Circle number (41) on reply card.

Chemical Processing . . . a new 12-page brochure (S.A1133) describing equipment, processes and services for the chemical processing industry is now available. *De Laval Separator Co.*
Circle number (42) on reply card.

Chempump Bulletin . . . new 8-page, 2-color Bulletin 1050-4 gives design features and model specifications of chempump series C sealless "canned" pumps for leakproof pumping of corrosive, toxic, explosive, radioactive and other problem fluids. *Fostoria Corp.*
Circle number (43) on reply card.

Chemicals . . . a new 4-page bulletin entitled Corrosion Resistance Chart J-CRC, lists over 150 different chemicals and their recommended usage with ductile iron, iron, steel, stainless steel, monel, brass, bronze, copper, aluminum and plastisol plastic. *OPW-Jordan Corp.*
Circle number (44) on reply card.

Competition . . . 32-page illustrated booklet showing how technology constantly expands the number and variety of products in the market, titled, "The Story of Competition in the American Market." *E. I. duPont de Nemours & Co., Inc.*
Circle number (45) on reply card.

Controls . . . 16-page Bulletin J-105 features positioning and program controls. *Jordan Controls, Inc.*
Circle number (46) on reply card.

Engineering Information . . . and prices, along with pneumatic specialties such as compressor check valves, by-pass pressure relief valves and sight glass indicators, given in 2-page Bulletin F-44-RE. *OPW-Jordan Corp.*
Circle number (47) on reply card.

Glasteel Pipe . . . is described in a new bulletin No. 989. New Glasteel pipe (glass inside, steel outside) can easily be field cut to required length. *The Pfaudler Co.*
Circle number (48) on reply card.

Industrial Heat Exchanger . . . selection data form is now available to enable engineers to obtain precise information regarding the efficient size and type of heat exchanger required for a particular operation. *The Air Preheater Corp.*
Circle number (49) on reply card.

Instruments . . . condensed Bulletin M-1 briefly describes line of precision instruments for measuring, indicating, recording, and controlling the rate of flow of all types of fluids. *Schutte and Koerting Company.*
Circle number (50) on reply card.

Leakproof Pumping . . . application of sealless "canned" pumps for leakproof pumping of ethylene and propylene chemicals is discussed in 3-page technical Bulletin No. 2. *Fostoria Corp.*
Circle number (51) on reply card.

Metallic Connectors . . . technical catalog sheet has just been released on flexible metallic connectors. *Pennsylvania Flexible Metallic Tubing Co.*
Circle number (52) on reply card.

Mechanical Joining of Aluminum . . . an illustrated, 32-page technical handbook, explains the best ways to mechanically join aluminum parts, and describes mechanical fastening methods for aluminum. *Reynolds Metals Co.*
Circle number (53) on reply card.

Mersemetric Pump . . . requires no other openings in the tank except the one at the top, because of the submerged liquid end . . . no bottom connections and no external leakage; Bulletin 1153-c gives complete details and illustrations. *Milton Roy Company.*
Circle number (54) on reply card.

Karbate . . . impervious graphite entrainment separator modules, type MV, for effective separation of entrained liquids from corrosive gas streams is described in an available 2-page illustrated bulletin. *National Carbon Co.*
Circle number (55) on reply card.

Magnox Analyzer . . . as explained in Bulletin 1059, provides accurate data for efficient fuel burning, permits economical ceramic firing and closer control of kiln atmospheres, measures the purity of oxygen and of nitrogen. *Milton Roy Co.*
Circle number (56) on reply card.

Plastics . . . table of properties reprinted from Modern Plastics Encyclopedia, shows significant physical, electrical, chemical and optical properties of nine thermoplastic materials. *Cadillac Plastic & Chemical Co.*
Circle number (57) on reply card.

EFCO's Four Point Program Provides:

- service-proved engineering design
- guaranteed job-ratings
- complete fabricating facilities
- technical service before, during and after installation

One reason that Efco does it *right* is its many years of experience in designing and fabricating heat-exchangers for the wide range of temperatures and pressures represented by ethylene plants and platinum catalyst reforming units. We are recognized specialists in handling all grades of carbon, alloy, and stainless steels, nickel, aluminum, and special low-temperature materials.

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ASK OUR GULF COAST CUSTOMERS—THEY KNOW US WELL

Write for General Catalog

ENGINEERS AND FABRICATORS, INC.

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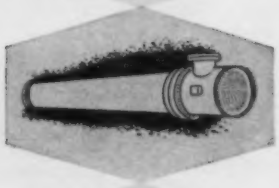
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Lengthen Condenser and Heat Exchanger Life

John Crane

Plastic* Tube Protectors

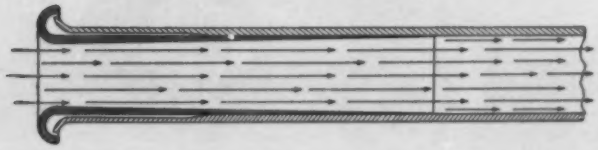


- Protect tube ends for life of tube.
- Positively prevent erosion and abrasion.
- Reduce costly tube maintenance and replacement.
- Easy to install—just slip into tube inlet after coating outer surface with cement.

* Nylon, Polyethylene or Phenolic Resin

PLUS EXCLUSIVE FREE-FLOW DESIGN

Wall thickness gradually tapers toward discharge end. Assures smoothest possible water flow, eliminates turbulence.



Get the facts. Request new Bulletin P-335.

John Crane

CRANE PACKING COMPANY

6486 Oakton Street, Morton Grove, Illinois (*Chicago Suburb*)

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

New Literature

Oil Cooler . . . Catalog, being a 10-page, 2-color Catalog numbered 1059, lists complete data on oil to air and oil to water oil coolers for torque converters, industrial applications. *Young Radiator Co.*
Circle number (58) on reply card.

Pumps . . . metering commercial grades of sulfuric acid in volumes of less than 20 gal per hour should be protected from sludge; Bulletin 459 describes specially designed sludge trap and filter which effectively traps and removes concentrated sulfuric acid sludge. *Milton Roy Co.*
Circle number (59) on reply card.

Recorders . . . and recording control stations which continuously indicate and record the standard 4-20 ma d-c output of any Electrik Tel-O-Set transmitter or transducer, set forth in Specification FS-301-8. *Minneapolis-Honeywell Regulator Co.*
Circle number (60) on reply card.

Recording Oscillograph . . . is the subject of an illustrated 16-page brochure, Bulletin 1500. *Consolidated Electrodynamics.*
Circle number (61) on reply card.

Refractory Metals . . . Bulletin No. 978, is a new 8-page bulletin available. *The Pfaudler Co.*
Circle number (62) on reply card.

Regulators . . . control valves now have low flow sliding gate seats available for them; seats are self-lapping and self-cleaning in operation and give tight shut-off; complete information available in SRCc 2-60. *OPW-Jordan Corp.*
Circle number (63) on reply card.

Report of Activities . . . annual report of The American Society of Mechanical Engineers describes engineering's new horizons and the mechanical engineer's part in shaping them. The newly-published 24-page booklet covers events in the 1959 fiscal year of ASME. *American Society of Mechanical Engineers.*
Circle number (64) on reply card.

Thermal Insulations . . . for all types of commercial and industrial requirements, in applications, are completely described in a new 54-page catalog. *Johns-Mansville Sales Corp.*
Circle number (65) on reply card.

Thermocouples . . . with hot junctions, bare wire and open end extensions, etc., are all illustrated and listed in a new brochure, Catalog No. 101. *Research Instruments, Inc.*
Circle number (66) on reply card.

Transmitter . . . Specification FS 1003-2a for details on specifications, ordering information, typical applications, method of operation and features. *Minneapolis-Honeywell Regulator Co.*
Circle number (67) on reply card.

Turbo-Mixer RDC . . . Bulletin #T-1159, "Turbo-Mixer RDC," a brochure giving information concerning the Turbo-Mixer Rotating Disc Contactor, gravity-flow countercurrent extractor. *General American Transportation Corp.*
Circle number (68) on reply card.

Valve Catalog . . . A newly revised version of comprehensive 500-page valve catalog, "Catalog '60," featuring a special 24-page valve selector and over 100 pages of valuable engineering data. *Lunkenheimer Co.*
Circle number (69) on reply card.

Vacuum Pump . . . 15-page, 2-color, Roots High Vacuum Pump brochure, giving information on the pumps and processes involved. *Consolidated Vacuum Corp.*
Circle number (70) on reply card.

Refining Equipment

Recorder-Receiver

Several new, more sensitive and versatile recorder-receiver arrangements have been announced. Design features include a newly engineered power positioner with faster, quieter response. *B-I-F Industries, Inc.*

Circle number (71) on reply card.

Sampling Valve

A new sampling valve designed to deliver perfect live samples, not affected by settlement or clogging has been announced. Accomplished by the stainless steel piston which, in closed position completely fills the valve body and extends to inner surface of the vessel. *Strahman Valves Inc.*

Circle number (72) on reply card.

New Catalyst

New palladium-carbon hydrogenation catalyst is offered in a standard grade 936, with soda as sodium oxide about 0.6 percent by weight, and a special low soda grade 937, with about 0.04 percent sodium oxide; in either grade normally supplied as wet cake, about 50 percent moisture. *Davison Chemical Div., W. R. Grace & Co.*

Circle number (73) on reply card.

New Fuel Additives

A new line of fuel additives is available, the two types being the inhibitor or preventive type and the inhibitor-dispersant type. *Tretolite Co., div. of Petrolite Corp.*

Circle number (74) on reply card.

Seamless Tantalum Tubing

Seamless tantalum tubing in lengths up to 60 ft have been announced. Virtually unaffected by highly corrosive acids, seamless tantalum tubing is made by extruding a solid piece of metal through a die, and thus it is free from welds and joints. *Wolverine Tube Div., Calumet & Hecla, Inc.*

Circle number (75) on reply card.

Pressure Transducer

A flush-mounted pressure transducer with improved high-frequency performance to supplement its recently introduced "high performance" line of unbonded strain gage pressure transducers is designed for use where accuracy must be maintained under rugged environmental conditions. *Consolidated Electrodynamics Corp.*

Circle number (76) on reply card.

Effective Silencer

A new effective silencer for quieting the discharge of steam, gas and air exhausts, also serves to collect and separate condensate. Actual test data proving the overall sound pressure level is reduced to approximately 80/86 decibels at 100 ft. *Pulsation Controls.*

Circle number (77) on reply card.

Silicon Rectifiers

Five new P-N-P-N diffused silicon controlled rectifiers, rated at 1 ampere from 50 to 400 volts have been announced, the first controlled rectifiers packaged in a JEDEC TO-5 case, an accepted industry standard for semiconductors. *Texas Instruments, Inc.*

Circle number (78) on reply card.

FAST, Lightweight
Greenlee Hydraulic Benders for 1/2"-4" Conduit and Pipe

full 90° bend with one ram stroke

NEW GREENLEE No. 883 Lightweight Hydraulic Pipe Bender quickly makes accurate bends in eight sizes of pipe from ½" through 3" . . . up to 90° with one ram stroke. Operates with either a portable power pump or hand pump. Makes 90° bend in 3" pipe in approximately 1 minute with power pump . . . only 10 minutes with hand pump. One set of rotating supports for all eight pipe sizes . . . supports also serve as rollers for wheeling bender from job to job. Pipe is easily inserted and removed from front of bender. "Quick-removal," positive-locking support pins cannot come loose. Bending gauge included for accurate results with minimum calculations. Get details now on the complete GREENLEE Lightweight Bender line that includes three models for ½" - 2" . . . ½" - 3" . . . and ½" - 4" pipe.

new, fast ratchet bender for ½", ¾", 1" pipe

GREENLEE No. 1800 Ratchet Hand Bender permits short, powerful strokes for easy, quick bending up to 90°. Swing-away clamp makes loading simple. Sturdy T-iron base sets anywhere or receives threaded pipe legs of any desired length. Built-in bending gauge reads 0 to 90°. See your distributor for a demonstration, or write for descriptive Bulletin E-291.

A COMPLETE LINE OF HYDRAULIC AND HAND BENDERS FOR PIPE AND TUBING

GREENLEE TOOL CO.

1757 Columbia Ave., Rockford, Illinois

GREENLEE

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

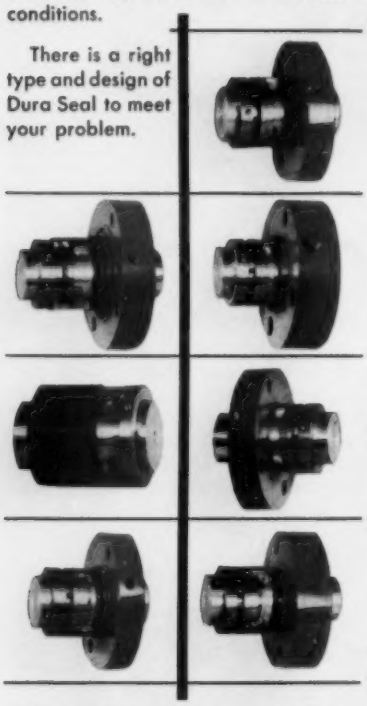
DURA SEAL

means VERSATILITY *in mechanical sealing*

Dura Seal is the most extensive line of mechanical seals offered to industry today . . . meeting a wider range of pressures, temperatures and liquids.

Dura Seal is backed by 25 years of experience in the successful sealing of corrosive, volatile and abrasive conditions.

There is a right type and design of Dura Seal to meet your problem.



For further details, write for free copy of Catalog No. 480PE

The PERFECT SEAL

DURAMETALLIC CORPORATION
KALAMAZOO, MICHIGAN

New Equipment

New Valve

A new, simple and compact valve for general pipeline and manifolding service, available in both lever and hand wheel operated models, in sizes ranging from 2 to 36 in. *Grove Valve and Regulator Co.*

Circle number (79) on reply card.

Capacitance-Type Probe

For use in level gaging systems, capacitance-type probe is designed to accurately determine height of conducting material such as coke, coal, wet sand, ores and similar types of granular abrasive solids. Principle of operation is based on change in capacitance caused by corresponding change in height as material being gaged rises within or around the probe. 959-30 probe consists of glass fiber epoxy tube with conductive film on inner wall. This construction displays superior abrasive resistance. Standard probe length is up to 10 ft. However, up to 50 ft may be obtained by adding additional screw-on sections. Probe can be engineered to provide temperature compensation to meet wide range of operating conditions, and capacitance variation can be made to give a linear volume versus level indication by shaping area of inner conductive coating. *Magnetic Instruments Company, Inc.*

Circle number (80) on reply card.

Centrifugal Air Compressor

High efficiency, multi-stage centrifugal air compressor has been designed to furnish "100 lb air" for oxygen plants, centralized air systems and other industrial air applications. Series features integral intercoolers between each stage of compression for highest possible efficiency. Six case sizes are available with hp ranging from 1000-8000 bph and capacities from 5000-38,000 cu ft per min. Each unit is furnished as complete package including matching driver, intercoolers and lubricating system. *Clark Bros. Company.*

Circle number (37) on reply card.

Pump Motors

Dripproof close coupled pump motors in rerated frame sizes are available from ½ hp at 900 rpm - 75 hp at 1800 rpm — frames 182-405 U, and explosion proof and totally enclosed fan-cooled from ½ hp, 900 rpm - 30 hp, 900 rpm - 30 hp — frames 182-326 U. Newly designed frames are rigid, seasoned, cast iron with integrally cast feet. Cast iron endbells have precision machined registers and bearing fits. Deep-drawn baffle plates in endbells provide extra protection for winding. Connection boxes can be rotated to make connecting easier. Motors can be furnished 3 or 2 phase and in all frequencies and commercial voltage below 600 v. *The Lima Electric Motor Company, Inc.*

Circle number (38) on reply card.

Gas Recovery Plant

Simplified processing plant has been developed which recovers both natural gasoline and liquefied petroleum gases from rich or lean natural gas streams. Packaged plant consists of 4-tower closed regeneration system incorporating fractionating and refrigeration equipment. Adsorbent beds of both silica gel and activated carbon are utilized in patented unit. *Delta Tank Manufacturing Company, Inc.*

Circle number (39) on reply card.

Glass Also in Colors

Protected inside and out with special acid-resistant glass, these new smokestacks provide the toughest protection against acid condensate, are almost 100 percent impervious to the accelerated corrosion normally encountered at low flue gas temperatures, should offer a life span of more than 3 to 5 times that of plain steel stacks in similar service. *A. O. Smith Corp.*

Circle number (40) on reply card.

Stabilizer

A new process for stabilizing formaldehyde that makes it possible to reduce storage temperatures by 15 to 20 deg F has been announced, together with a number of the advantages offered by this new stabilized formaldehyde. *Celanese Corp. of America.*

Circle number (114) on reply card.

Packaged Heaters

The development of an economical and convenient pre-packaged assembly for complete line of fired heaters is announced, with all combustion, flame safety and automatic control equipment mounted in position, wired and ready for operation. *Brown Fintube Co.*

Circle number (115) on reply card.

Piston Filler

A new 10 station rotary piston filler that combines speed and accuracy has been introduced, designed to operate at speeds up to 300 containers per minute and with accuracy of 1/10 fluid ounces. *The Pfaudler Co.*

Circle number (116) on reply card.

Temperature Regulator

A new self-powered temperature regulator especially designed for use on gas fired petroleum heaters and treaters is a rugged device built to withstand severe service conditions. *Fulton Sylphon Div., Robertshaw-Fulton Controls Co.*

Circle number (117) on reply card.

Urethane-Foam

A light-weight, rigid, urethane-foam pipe insulation, specially designed for use at temperatures ranging from minus 300 deg F to plus 220 deg F has been announced. Manufacturer claims that it has the lowest known K factor for a commercially available product of its type. *Union Asbestos & Rubber Co.*

Circle number (118) on reply card.

Man-Machine Coupling

A group of electronic data input and output machines has been announced, which print characters serially, provide the man-machine coupling to data processing and data handling equipment. *Royal McBee.*

Circle number (119) on reply card.

Insulation

A new product in the field of thermal insulation is a castable quick-set, one-coat insulation cement. It can be packed by hand, troweled, injected, palmed, sprayed, or poured to any thickness. *Thermold Products Co.*

Circle number (120) on reply card.

Oakite ECP
engineered cleaning program

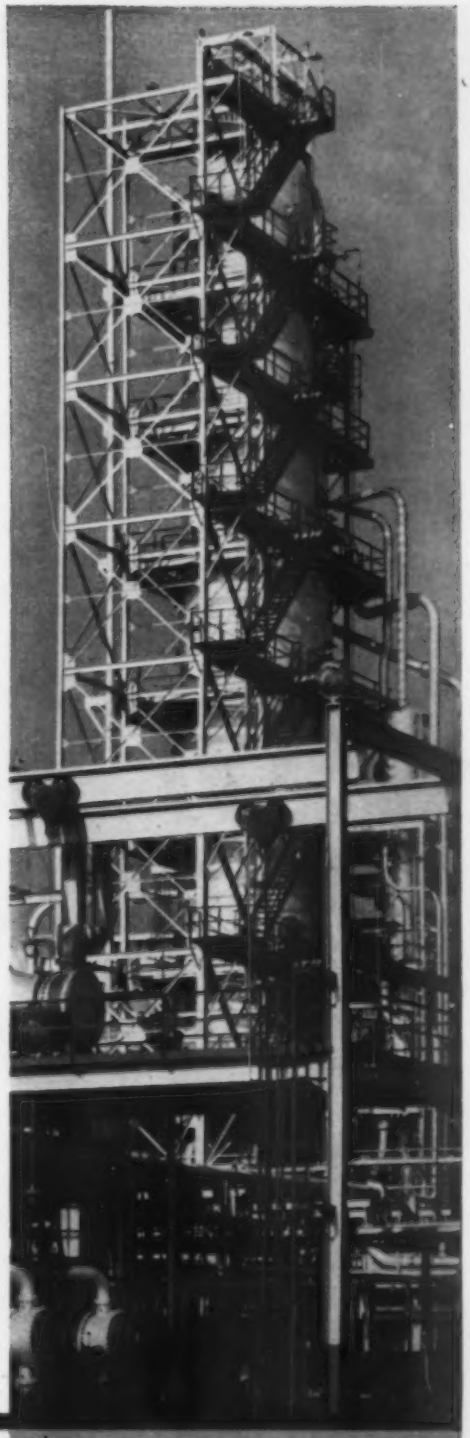
gets crude tower nearly 100% clean

Could results as good as 85% clean be made even better in clearing crude oil deposits from vacuum tower? The Oakite engineer thought so. He revised one refinery's ECP*.

For next turnaround, he recommended circulating a solution of Oakite 77 and Oakite 8 through the tower. Meanwhile, heat exchangers below were soaked and steamed. Then reversing procedure the solution circulated through the heat exchangers while tower was steamed. This kept up for 15 hours—followed by rinsing and inspection. Results: *99% perfect.* Hosing knocked off the last remaining bits of soil. In just 21 hours, tower and exchangers were cleaner than they'd ever been.

WHAT IS OAKITE ECP* It's an *Engineered Cleaning Program* that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation —tower to tank.

The Oakite specialist lends his personal cooperation and practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by *materials* known to make short work of refinery soils, by proved *methods*, by detailed *engineering data.* Send for Bulletins. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.



OAKITE
50 years' leadership in industrial cleaning
SCIENCE

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

Oakite ECP
your economy key

REFINING PERSONALS

Brunner C. Barnes and **Robert R. Click** have announced the formation of Barnes & Click, an engineering firm to specialize in consultation and design work related to natural gas production and processing, with offices in Dallas. Both formerly with

B. C. Barnes

R. R. Click

Mobil Oil Co., Dallas, Barnes joined Mobil's predecessor, Magnolia Petroleum Co. in 1940, and since 1953 was Chief Process Design Engineer in Magnolia's Natural Gas Dept. Click joined Magnolia in 1949 and was the Natural Gas Dept.'s Senior Operations Control Engineer.

New engineers at the Process and Plant Design Division at the Richmond Laboratory, California Research Corporation, are: **Larry Mank** who received his MS in chemical engineering from the University of Minnesota; **L. M. Davis** who recently received his MS in chemical engineering at the Massachusetts Institute of Technology, and, **Dr. A. R. Van Kleeck,** from Battelle Memorial Institute.

Robert D. Crane as Director of Purchases and Traffic has been announced by **J. B. O'Connor,** President of Dresser Industries, Inc., a leading manufacturer of equipment and machinery for the oil, gas, chemical and electronic industries, replacing **Robert C. Kelley** who is retiring.

Paul T. Atteridg has been appointed Manager, Refinery Plans Division, announces the M. W. Kellogg Co., New York, a subsidiary of Pullman, Inc., to supervise a group of specialists who aid their refinery and petrochemical clients in planning new processing installations in the U. S. and Western Hemisphere.

Dr. Carl H. Samans, director of the engineering materials division of the research and development department of Standard Oil Company (Indiana), has been elected chairman of the Chicago Section of the American Institute of Mining, Metallurgical and Petroleum Engineers.

T. C. Jones

Thomas C. Jones became president of Nalco Chemical Company, Chicago, on January 1, succeeding **Joseph A. Holmes,** who became vice chairman of the board of directors.

O. V. Tracy has been elected president of Esso Standard Oil Company, succeeding **William Naden,** and **Robert H. Scholl** succeeds **E. Duer Reeves** as executive vice president (Reeves and Naden are now with the Humble Oil & Refining Com-

O. V. Tracy

R. H. Scholl

pany.) Mr. Tracy has also been named a member of the board of directors of the Neward College of Engineering Research Foundation, it has been announced by **Dr. Robert W. Van Houten,** president of the foundation and college.

Robert W. Andrews will serve as a Process Engineer for Southwest Industries, a firm which specializes in the design and construction of process equipment for the oil and gas industry. He was formerly with the consulting engineering firm of Prengle, Dukler and Crump.

M. D. Gilchrist, M. R. Schrein, and **R. E. Sutherland,** have been elected Senior Vice Presidents, announces David W. Harris, Chairman of the board of directors of Universal Oil Products Co., which company is a leader in the development of processes for the petroleum, petrochemical and chemical industries.

DETERMINE Moisture CONTENT of JET FUELS OILS GASES with the MODEL W ELECTROLYTIC MOISTURE ANALYZER

Full scale on most sensitive range,

to one milligram of water per liter of liquid. To 10 p.p.m. of moisture by volume in gases.

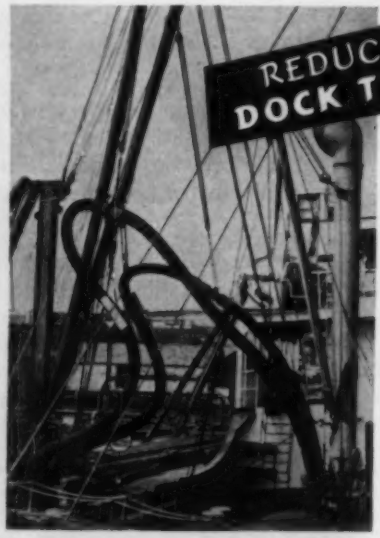
Direct reading scales— no computation necessary.

Includes novel self checking features.

Write for complete information.

Explosionproof Universal Model W. (Other models including portable models for moisture in gas are available.)

MANUFACTURERS ENGINEERING & EQUIPMENT CORP. Sunset Lane & York Rd. • Hatboro, Pa. MECCO Instruments



WITH PARANITE LOADING HOSE

- Hycar Tube—High-Octane Resistant
- Uniform Bore Assures Rapid Flow—Suction and Discharge
- Oil, Abrasion and Weather Resisting Neoprene Cover
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- 7 Types for Pressures to 200 psi.

Paranite Loading Hose for years has been recognized for long service.

Furnished in 7 types, smooth-bore, rough bore, for sea and dock ship loading and for barge service.

Ask about R/M Rotary Hose, Mud Pump Intake Hose, Vibration Hose, and Non-Bursting Steam Hose.

RM 1047

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY
ENGINEERED RUBBER PRODUCTS.. MORE USE PER DOLLAR

Quick dissolving and free flowing, Du Pont improved flaked petroleum dyes take approximately half the space of the powdered form.

Free flowing Du Pont *flaked* dyes offer refineries important advantages

Du Pont offers oil colors either in powder or flaked form.

Since Du Pont flaked dyes are virtually dust free, they have been gaining steadily in popularity. And now the newest flaked dyes from Du Pont are further improved; they dissolve more readily than ever.

Less bulk. You'll find that the flaked Du Pont Petroleum Dyes take approximately half the space of the same dye in powdered form, thus saving valuable storage space. Flaked dyes are shipped in easily handled small drums.

Wide color range. You can get Du Pont flaked dyes in orange, red and bronze. Blue is supplied in a crystalline form offering approximately the same advantages as you get when you use Du Pont flaked dyes.

More information. For more details and samples, contact your Du Pont Petroleum Chemicals representative. Or write to: E. I. du Pont de Nemours & Company (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

DU PONT

Better Things for Better Living
... through Chemistry

Tetraethyl Lead
and other
Petroleum Additives

Personals

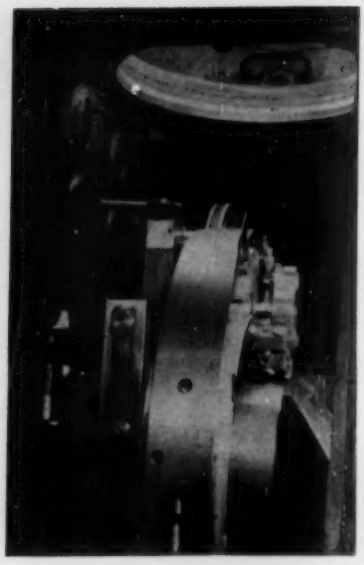
George Tobiasson

Jack Conviser

George Tobiasson, supervisor of the Catalyst Evaluation Laboratory, and **Jack Conviser,** manager of the Purchasing Department, are enjoying the distinction of being the first 40-year men (service mark) with Universal Oil Products Company, Des Plaines, Illinois.

Jerry McAfee, of Pittsburgh, a Gulf Oil Company vice president, has been elected president of the American Institute of Chemical Engineers (by a mail ballot). **John J. Healy, Jr.,** of Monsanto Chemical Company, St. Louis, was named vice president, and **Dr. J. Henry Rushton** of Purdue University and **Frank J. Antwerpen,** of Nutley, New Jersey, were re-elected treasurer and executive secretary, respectively.

Dr. Edward D. Amstutz has been named head of the department of chemistry at Lehigh University (Bethlehem, Pennsylvania), it has been announced by **Dr. Harvey A. Neville,** vice president and provost, succeeding **Dr. Earl J. Serfass** who resigned to become a member of the board of directors and vice president in charge of research and development of the Milton Roy Company, Philadelphia.



...Refinish Crank-Pins ...In Place!

• Accurate High Quality Maintenance And Machine Work

The small engine crank pictured above was restored in close quarters without dismantling engine. Our portable machines can solve your problems and save you money. Crank pins from 5½" through 20" in diameter accurately refinished in place at great saving in cost. **Let us help you minimize down time.**

Worn and damaged flywheel fits refinished in place.

In our shop crankshafts of any size or type completely refinished. Shafts straightened and broken shafts successfully repaired.

Most modern methods used in rebabbitting and machining engine and turbine bearings.

All types of heavy power plant equipment serviced with special attention given to emergency repairs.

Additional information furnished without obligation.

WASHINGTON IRON WORKS, INC.
Established 1876
SHERMAN, TEXAS
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for leakproof, pressure-tight connections

use TiteSeal®

SEALING COMPOUNDS

Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion, joint seizure.

7 BASIC BLENDS

LIQUID WRENCH®
The super-penetrating rust solvent

LOOSENS rusted bolts, nuts, screws, 'frozen' parts

Liquid Wrench works *fast*...yet is absolutely safe for all metals and alloys.

2171

At Industrial, Automotive, Hardware, Plumbing Jobbers

RADIATOR SPECIALTY CO.
Charlotte, North Carolina

SOLDER SEAL

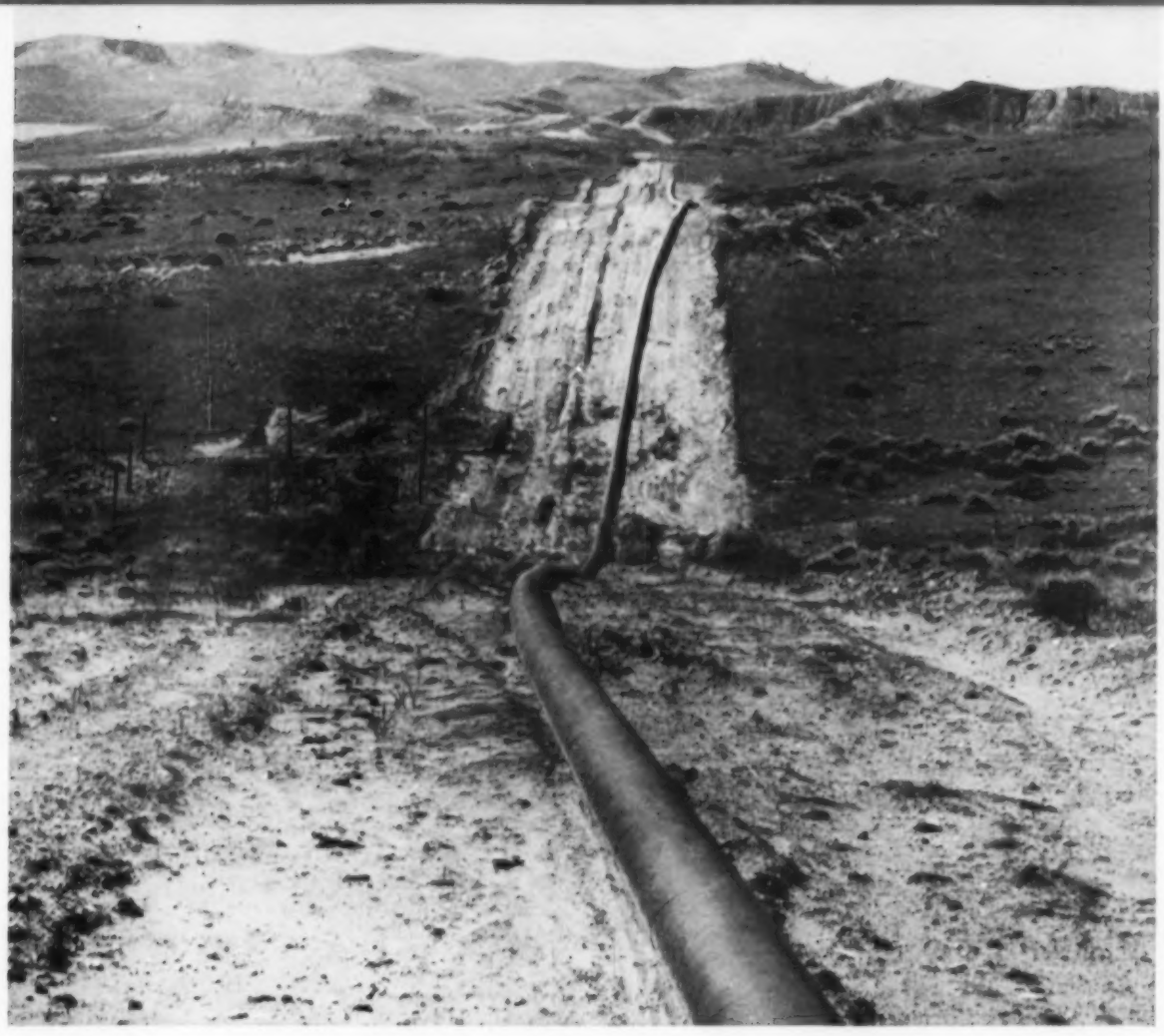
REPAIR PIPE LEAKS
QUICKLY PERMANENTLY
ANY PRESSURE
ANY TEMPERATURE

SKINNER-SEAL
EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

SKINNER-SEAL
COLLAR LEAK CLAMPS—for oil and gas lines. Gasket is sealed by gasket container rings—pressure is sealed in . . . air, moisture and gasket-destroying soil conditions are sealed out. Effective under any pressure. Sizes 2"—13" O.D. incl. In stock at oil supply stores!

For over half a century, a complete line of Repair Clamps and Saddles for steel and cast iron pipe. Send for catalog!

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA



Armco Line Pipe Combines Strength and Economy

New steels are born at Armco

Low residual stresses in line pipe mean more strength to handle unforeseen or accidental overloads. Tests show that the maximum residual stress in Armco Pipe is about 90 per cent less than in many commonly used standard pipes.

It's thrifty to specify Armco Line Pipe, too. You don't pay for "extra" steel—132 different diameter-wall thickness combinations let you meet your requirements *exactly*.

Write us for complete information on Armco Line Pipe. Armco Drainage & Metal Products, Inc., 5010 Curtis Street, Middletown, Ohio.

ARMCO DRAINAGE & METAL PRODUCTS

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. . . One of the Secrets of GASO'S 45-Year Record of Leadership

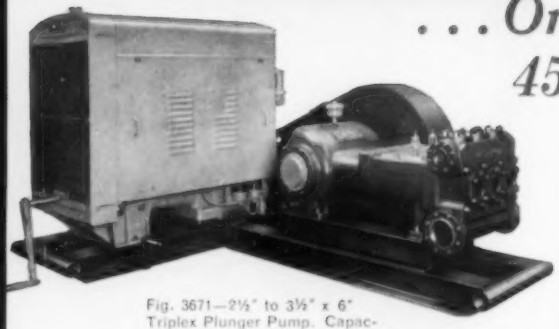

Fig. 3671—2½" to 3½" x 6" Triplex Plunger Pump. Capacities of 191 to 375 barrels per hour at working pressures from 1575 to 800 PSI.

No pump is stronger than the metal from which it is made, and no pump manufacturer casts his metal to more rigid specifications than Gaso. Here experienced foundry-men are preparing the mold for a Gaso power frame. Into it will be poured a special formula of molybdenum alloy cast iron. Test bars, sent regularly to a nationally known laboratory, consistently show a tensile strength of 45,000 to 48,000 lbs. per square inch. Another reason for the ruggedness of Gaso Pumps, their ability to withstand the shocks and strains of tough use, and their habit of outliving ordinary pumps . . . Latest catalog on request.

DISTRIBUTORS:

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Wichita Falls, Texas—Pump Engineering Co.
Evansville, Indiana—Hague Equipment Co., Inc.
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for every oil industry need

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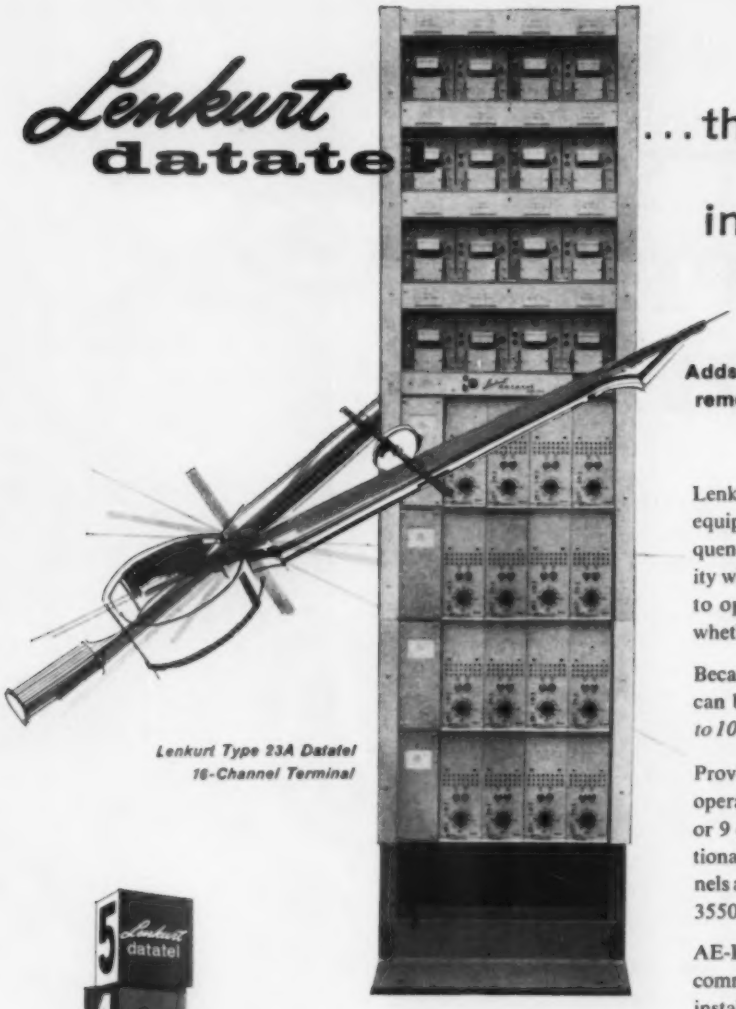

Lenkurt Type 23A Datatel
16-Channel Terminal

Adds high-speed telegraph, telemetering, remote control and digital transmission to any communication circuit

Lenkurt Type 23A Datatel telegraph carrier equipment offers a fully transistorized frequency shift system capable of great flexibility with minimum maintenance. It is designed to operate over voice-frequency circuits, whether physical, carrier-derived or radio.

Because of its unusual versatility, the 23A can be used initially for carrier telegraph *up to 100 wpm*—used now or later for automation.

Provisions are made for the simultaneous operation of 18 channels on a 4-wire circuit, or 9 channels on a 2-wire circuit. Eight additional 4-wire channels or four 2-wire channels are provided above the v-f range, between 3550 and 5050 cps.

AE-Lenkurt is equipped to handle *all* your communication needs – from planning and installation to equipment and supplies. *There's never need to look elsewhere.*

For full information on Lenkurt Datatel and companion equipment, as well as AE telephone equipment and supplies, call your Automatic Electric representative, or mail coupon today.

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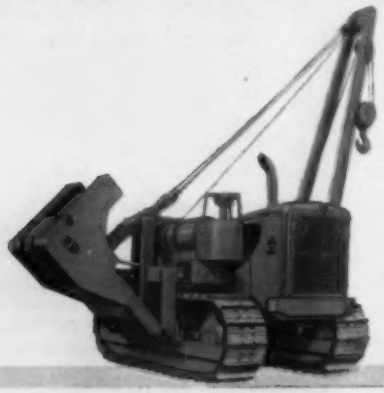
MIGHTY... HEALTHY... POWER

Whether your choice is the 225-hp HD-21 or the 150-hp HD-16, you get from 8½% to 27% more efficient engine operation than from other crawlers.

This fuel-pinching efficiency is a fact! Your Allis-Chalmers dealer will show you actual proof of up to 27% fuel savings in the Allis-Chalmers 16000 or 21000 engines over units of comparable size. He'll tell you why they run cleaner . . . how they "sip" fuel to earn the title "industry's healthiest engines."

Six crater-shaped pistons develop 225 hp in the HD-21, 150 hp in the HD-16 . . . both at an easy 1825 rpm. Coupled with torque converter drive, they provide plenty of rough dozing lugability . . . plenty of side boom liftability.

These big Allis-Chalmers tractors are built for mighty tough service . . . right-of-way pioneering, stringing, cradling, or lowering-in. Shock-absorbing all-steel main frame, durable double-reduction final drives, certified permanent lubrication of tapered roller bearing truck wheels, idlers and rollers, and extra tough track keep them going season after season with a minimum of maintenance. Your Allis-Chalmers construction machinery dealer will be glad to show you an HD-21 or HD-16 soon. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.



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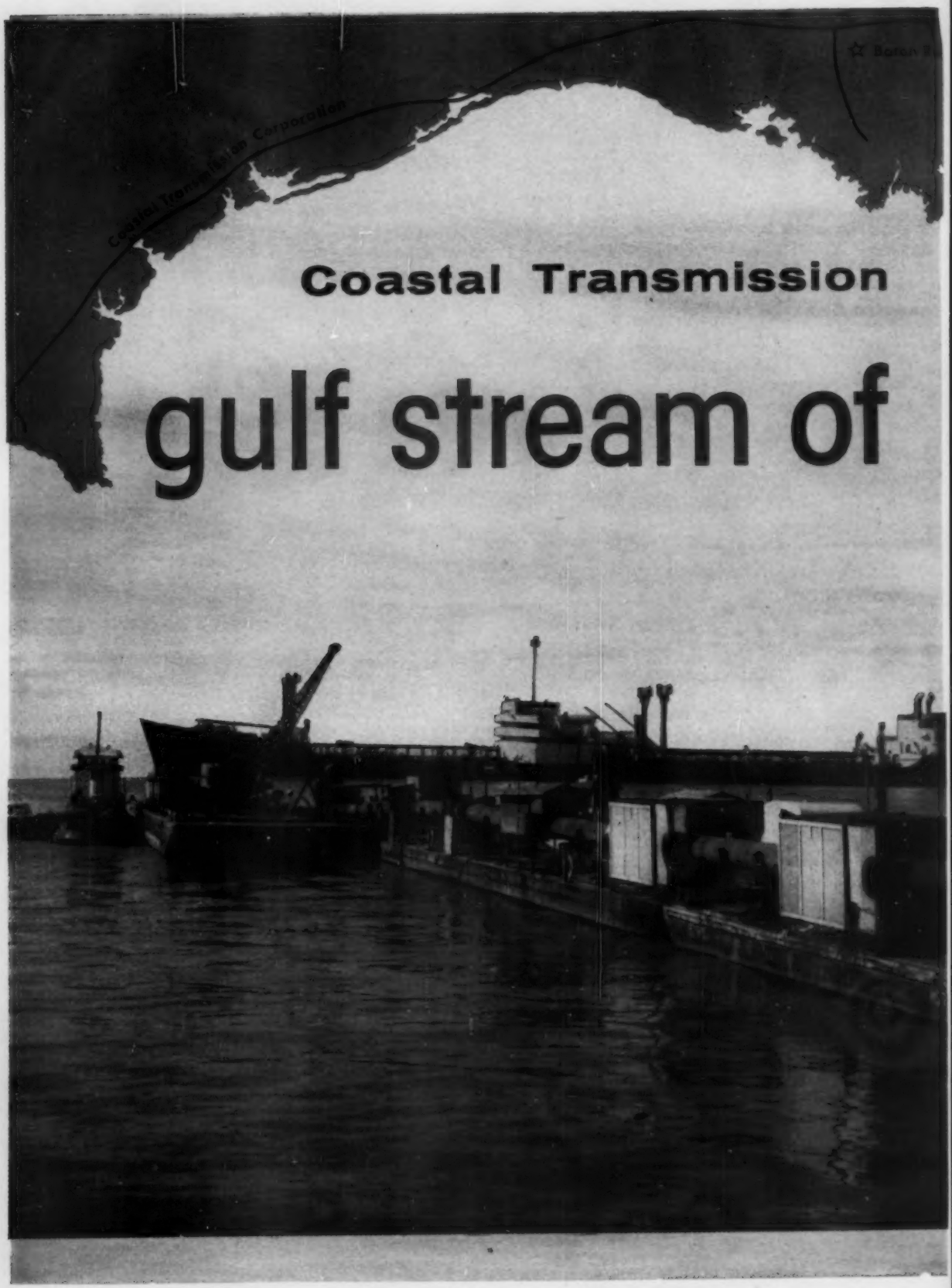
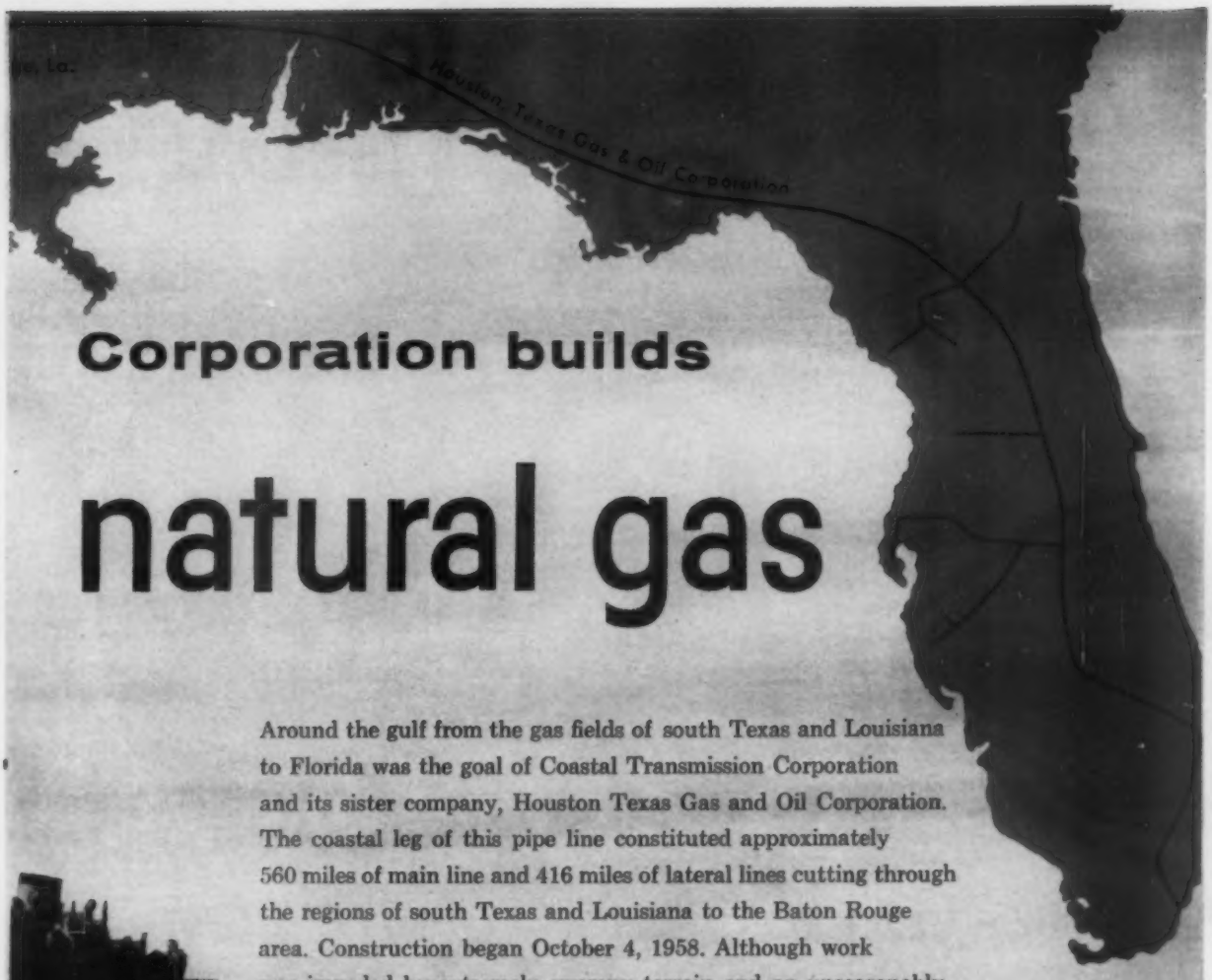
ALLIS-CHALMERS

power for a growing world



FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Corporation builds

natural gas

Around the gulf from the gas fields of south Texas and Louisiana to Florida was the goal of Coastal Transmission Corporation and its sister company, Houston Texas Gas and Oil Corporation. The coastal leg of this pipe line constituted approximately 560 miles of main line and 416 miles of lateral lines cutting through the regions of south Texas and Louisiana to the Baton Rouge area. Construction began October 4, 1958. Although work was impeded by extremely swampy terrain and an unseasonably wet spring, the line was completed by June of 1959.

A. O. Smith furnished 167.5 miles of 24-inch pipe and 91 miles of 20-inch main line pipe that spans this coastal region.

For almost 30 years . . . A. O. Smith line pipe has always been manufactured to a high standard of quality . . . precisely controlled at every step of production. That's why A. O. Smith pipe, made and installed in 1928, is still in operation. That's why so much A. O. Smith pipe is found in every important pipe line project.

CROSSING THE BAY — Approximately 11 miles of 24-inch pipe was laid across Galveston Bay. Special techniques had to be employed in crossing the busy Houston Ship Channel. All of Coastal's river crossings were submerged.

Through research ...*a better way*

A.O.Smith
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THE *NEW* ROOTS 3000 cfh* GAS METER IS "JUST A BULGE IN THE LINE!"

*Size 3M125 ½ actual size

Gas men who've previewed it are mighty excited about the cost saving features of the new Roots-Connersville 3000 cfh rotary gas meter. Only 14" long, a workman can pick it up with one hand and carry it under his arm.

Because it incorporates the famous Roots rotary positive displacement principle, accuracy is permanently locked in for the long, trouble-free life of the unit. Actuated by the gas flow itself, twin rotors displace a fixed volume of gas with each revolution, unaffected by variations in pressure or flow. Extremely close clearances between rotors assure accuracy while eliminating all friction and need for internal lubrication. Occasional replenishing of oil is the only maintenance required under normal operating conditions.

Here, is *the* efficient and economical way to meter industrial, commercial and institutional gas loads. Call in your Roots-Connersville sales engineer or write for complete data.

- Replaces meters several times its size and weight
- Only 14" long—mounts in the line
- A bare 53 pounds
- Accurate to 3000 cfh and up to 125 psi
- Easily installed
- Direct reading or can be instrumented
- Quickly tested on standard equipment
- Virtually eliminates maintenance
- Requires no special supports

SEE IT AT THE AGA CONFERENCE
New Orleans,
May 9-13, 1960

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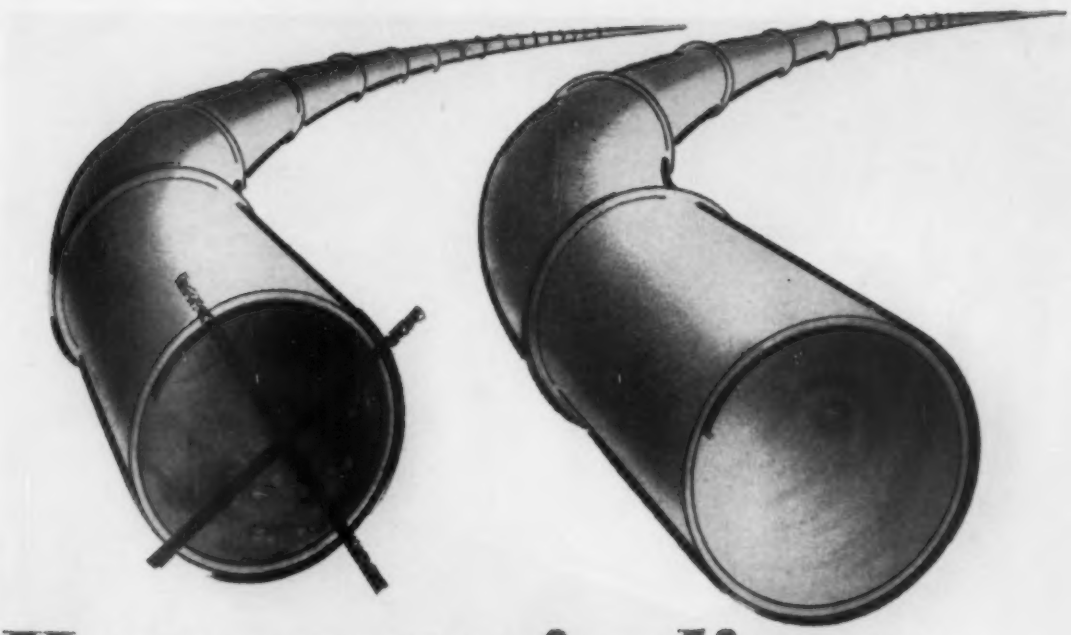

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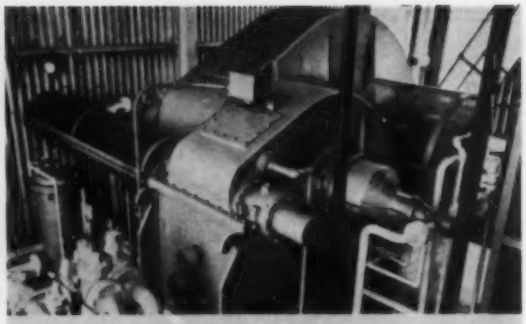

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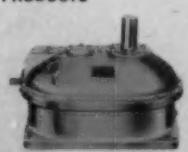
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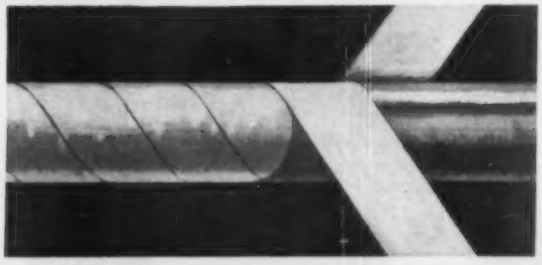

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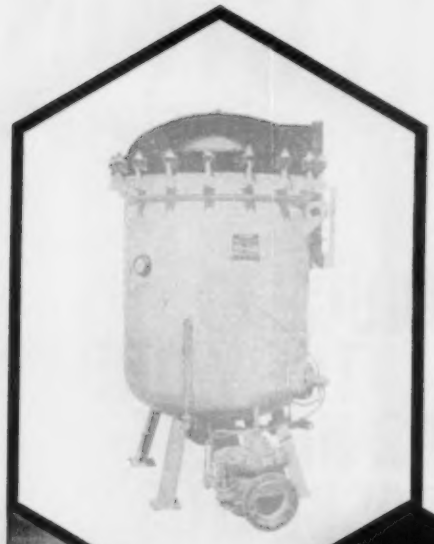

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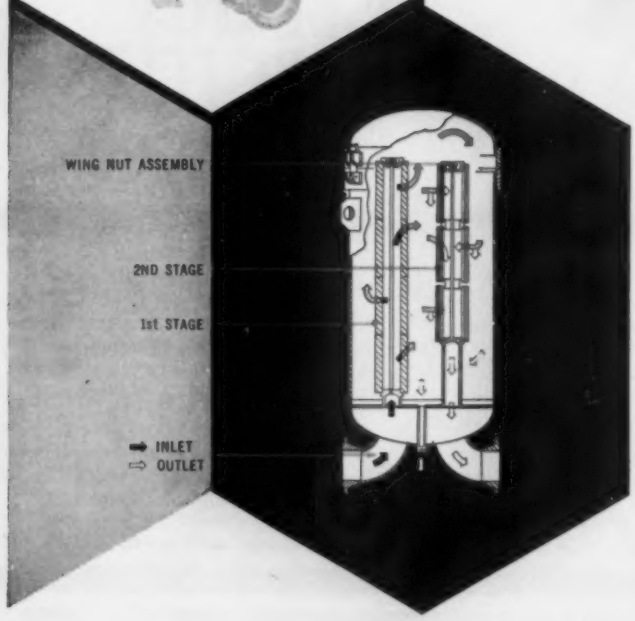

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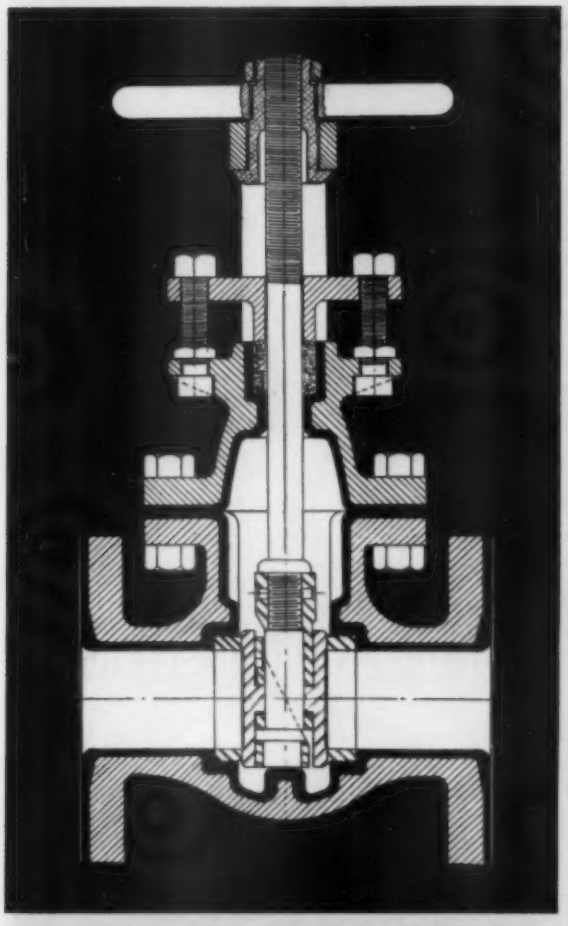

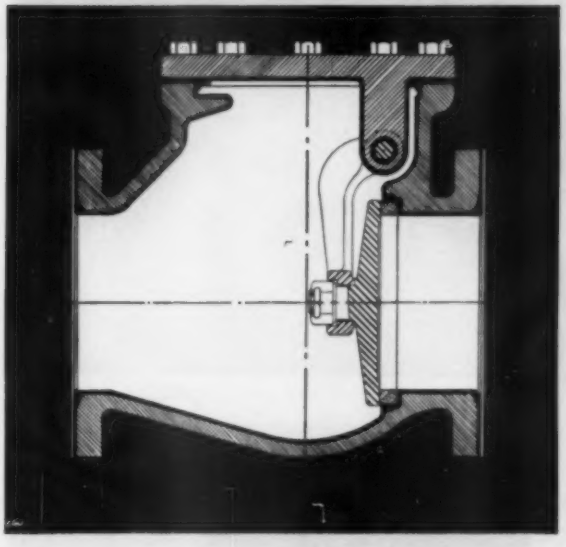

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RUBBER-LINED IRON BODY GATE VALVES

In many cases, you can save the cost of expensive alloy valves for corrosive or abrasive service. Darling rubber-lined gate valves offer you these advantages:

1. Iron body substantially reduces cost over special alloy valves.
2. Special hard rubber lining on bodies and bonnets (see diagram) provides high resistance to corrosion and abrasion.
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Available in outside screw and yoke type, in sizes from 2" to 24". Write for further information.

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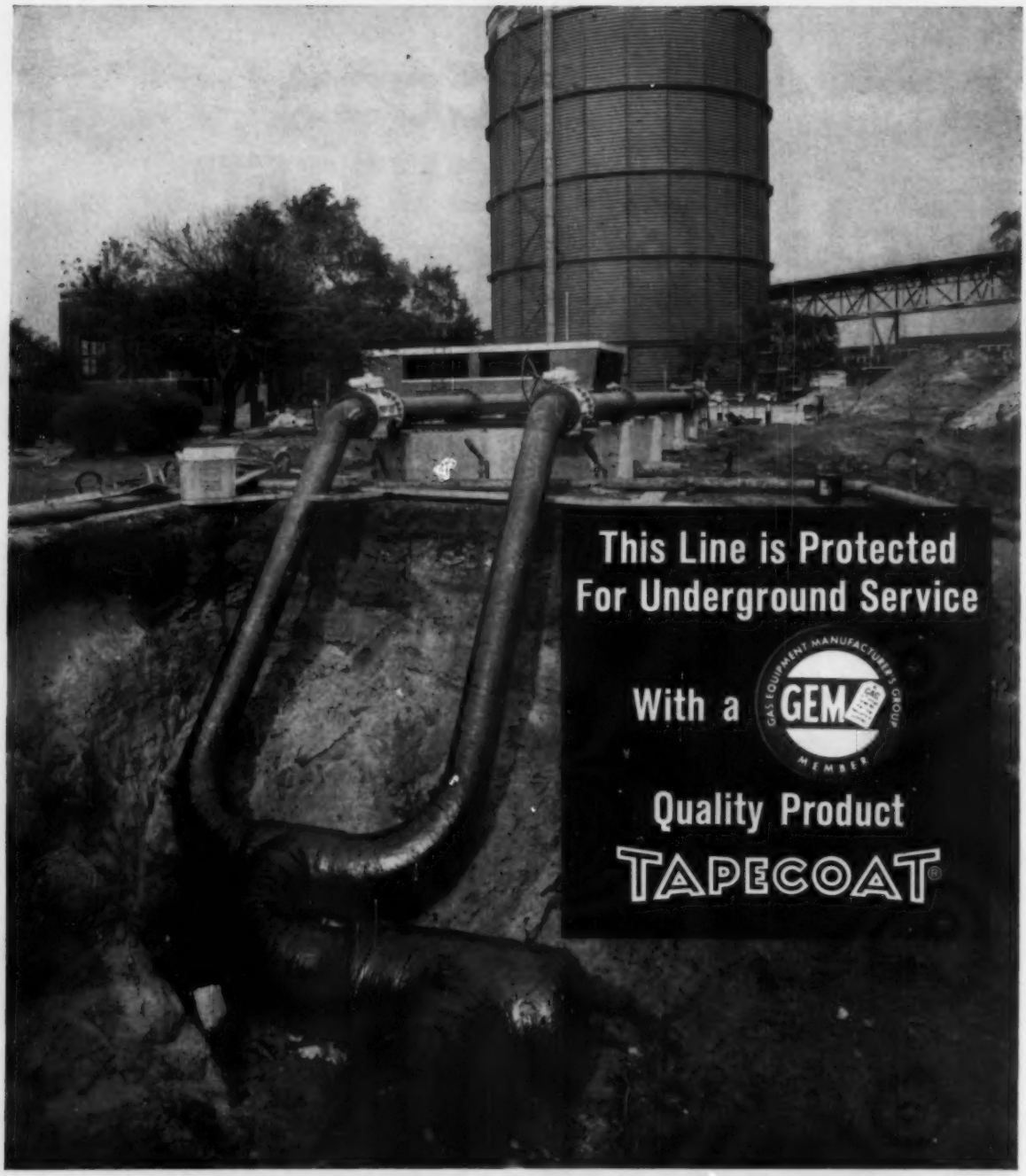

"TAPECOAT*ed*" means that the pipe has been coated with TAPECOAT . . . the original coal tar protection in handy tape form which has proved its dependability in underground service on pipe, pipe joints and other steel surfaces since 1941.

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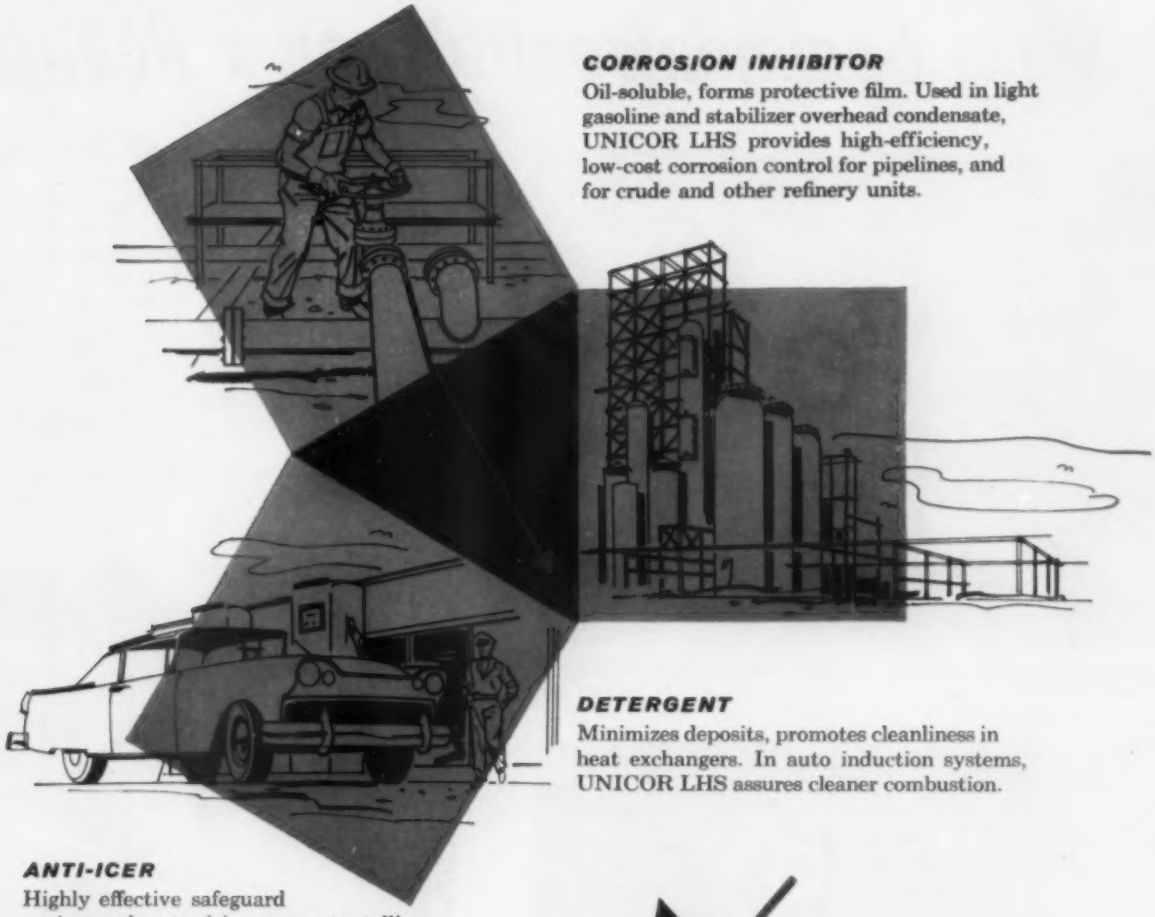
provides valuable refinery and pipeline service, too!



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THE FASTEST ROAD—and the cleanest—was often along the pipeline, itself.

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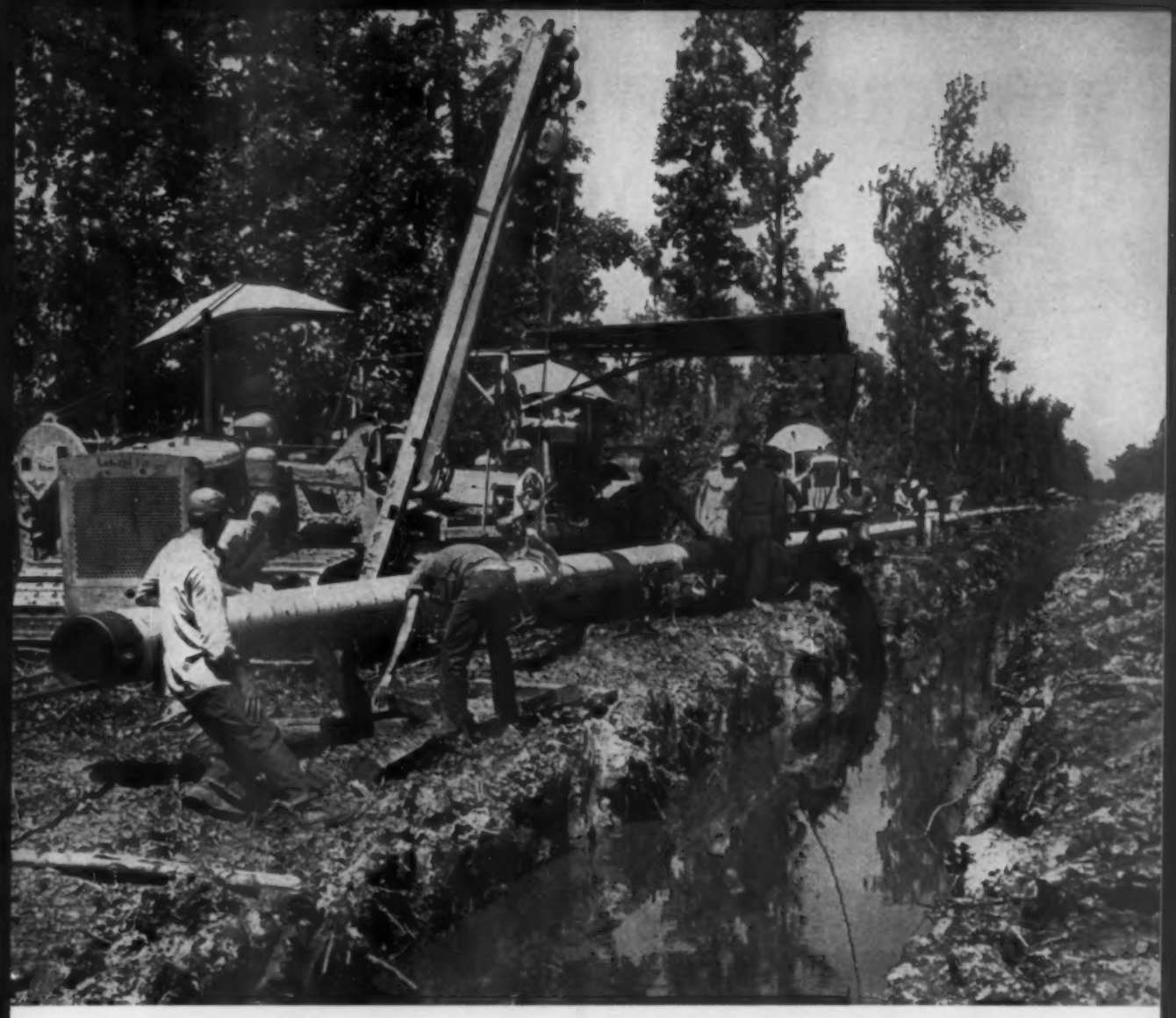

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BETHLEHEM STEEL

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*Trade name of Chase & Sons, Inc., long-famous for protective and insulating tapes for electrical wire and cable.

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The New CORR-PREV Pipe Coating Team

Try this new pipe coating *team* on your next job. From trenching to backfilling, CORR-PREV helps you shorten your spread . . . gives you a pipe coating that's *factory-uniform* in quality and thickness. Most important, you get today's *proven* polyethylene pipe protection at the *lowest applied cost!* Write for sample rolls, specifications and prices. **CHASE & SONS, INC., 26 Spruce Street, North Quincy, Mass.**

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WHERE COAL TAR PITCH-EPOXY RESIN COATINGS STAND TODAY

Within five years, new developments and means of application will determine whether or not this new family of coatings have a place in the pipeline industry

NEW DEVELOPMENTS in the formulation and application of the tar-epoxy resin coatings combined with field service reports on the performance of these coatings will show whether or not the coal tar-epoxy coatings have a place in the pipeline coatings field. This will probably be proved one way or the other within five years. However, new developments in synthetic resins and their adaptation to pipelines may move ahead of the tar-epoxies. Some of these will be seen on the market this year with rather new concepts in application; however, none of the known products of this type has any service records and must be treated as completely new products.

Because of the state of flux in which all of the newer coatings are at the present time, the coal tar hot applied coatings and to some extent the other standard hot applied coatings will predominate the pipeline coating field for at least another 10 years or more. It will take at least that long to prove or disprove the newer coatings.

Status of tar-epoxy resins. The position of tar-epoxy resin coatings today is much the same as that of several other new coatings placed on the market in the past 15 years; tried, changed, and tried again and again but not proved. They do show promise, particularly those that have undergone only slight change through the past four to six years. The general characteristics of these relatively unchanged (composition) coatings are given in Table 1.

There is little doubt that the tar-epoxy resin coatings have a good chance of taking a strong position in the pipeline coatings field some time in the future when all of the troublesome factors are corrected and they have had more time to be proved in service. It is known that some of the early field applications have failed, others are still in good condition. Of the known failures, one was a small diameter hot line that was hand coated to hand cleaned pipe using a double inner wrap of thin glass fabric. This failure was caused by the glass inner-wrap and poor cleaning. Two others are failures because the coatings were applied at 10 mils coating thickness or less and because of changing coating formulation. Subsequent applications appear much better.

How it all started. Coal tar pitch-epoxy resin coatings first became known in the field about the middle of 1953. Although the original coating was developed as a protective, relatively thin film for underground pipe-

TABLE 1. Characteristics of Good Coal Tar-Epoxy Resin Coatings.

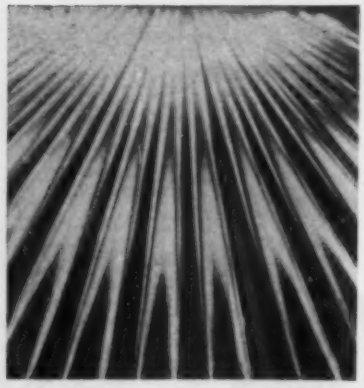
Electrical resistance	More than 1 megohm per sq ft.
Water absorption	Same as hot applied coal tar coatings: Less than 1.0%.
Adhesion to clean metal	Excellent, 1000 lb per sq ft.
Impact resistance	No shattering or disbonding, only chipping where struck.
Hardness, aged coating, shore durometer "D" scale	Approximately 65 to 75. (Golf ball surface about the same.)
Bending of pipe, (within one year of coating application)	No loss of bond, shattering or cracking on normal bends made in line and utility pipe.
Chemical resistance	Excellent.
Effects of cathodic protection	None up to 3 volts, pipe to soil potential.
Effect of soil stress	None.
Need for wrappers or reinforcing	None.

lines, the slow curing of the applied coating at ambient temperatures indicated that it was not adaptable to this service generally. However, because of its high temperature and good chemical resistance, it was thought that it might be excellent as an industrial coating and might be used on special pipelines where normal coatings were not serviceable. In spite of the difficulty of applying a thick two-component system of this type, it was soon being applied to small diameter pipe for underground, high temperature service and was being tested in a large number of different industrial applications.

Nature of the epoxy resins. The oldest and least known and used of the epoxy resins are those referred to as novolak or polyepoxy resins. These consist of a series of benzene rings each linked to the other through a carbon to carbon linkage. To each ring is an ether-epoxy linkage. The polyepoxy resin molecules usually consist of more than two rings each with an epoxy group. The more rings and epoxy groups, the harder the resin and the greater the brittleness. The more commonly used epoxy resins are sometimes called diepoxy resins because the molecule consists of alternating aliphatic and aromatic groups with ether-epoxy terminal groups on each end of the molecule. The structure also contains hydroxal groups which are thought to promote adhesion. The higher molecular weight resins are only an increase in the number of alternating aliphatic-aromatic groups but still retaining the terminal epoxide groups. In general this promotes less brittleness in the cured film.

Both types of resins may be cured to hard, chemically resistant coating films by the use of amines; primary, secondary and polyfunctional amines. In all probability the success of the epoxy resins can be attributed to their reaction with the amines or the polyfunctional amines creating no by-products of the reaction as do many other true catalytic processes. Because of the direct reaction of the amines with the epoxy resins, specific amounts of the curing agents or hardeners are required to give complete reaction. Too little or too much hardener results in soft films or non-hardening films. The hardeners fall into two groups; those that react with the resins at ambient temperatures and those that require heat or baking to create reaction. The ambient temperature curing agents may also be cured by baking.

Early in the use of the ambient cure epoxy resins it was found that their adhesion to metal was good except under continuous immersion. The coatings were hard, somewhat brittle but had excellent chemical resistance. At that time they could only be applied in thin films, chalked on atmospheric exposure but had excellent lasting qualities on metals out of sunlight. Baked epoxy resin coatings are excellent under practically all conditions except exposure to sunlight.



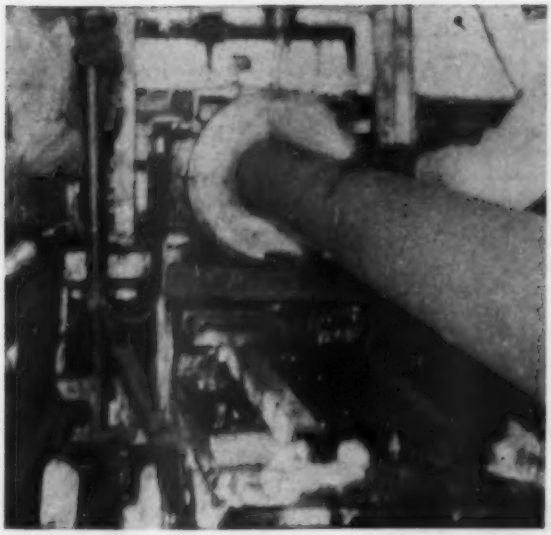
Tar-epoxy coating on 8-in. pipe. Cooling pipe on skids ready for loading. Extrusion head used in application to hot pipe.

Tar-epoxy coated 8-in. pipe on arrival in cars at destination. Shipping distance about 450 miles.

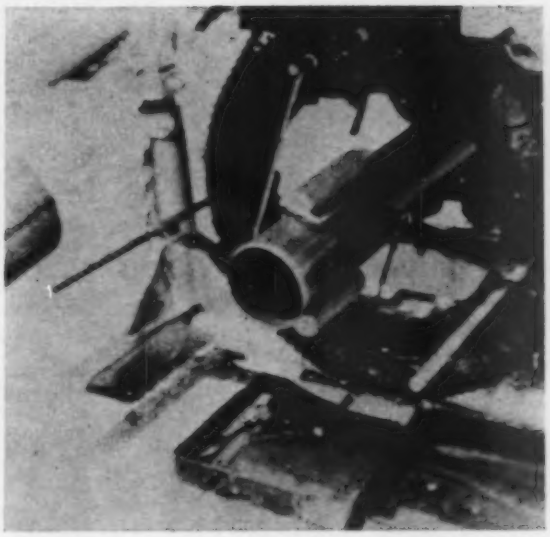
Coal tar pitch-epoxy resin coatings. The subsequent discussions of the coal tar pitch-epoxy resin coatings will refer to them only as tar-epoxy coatings for brevity. To avoid confusion it is advisable to give a short explanation of the nature of tars and pitches. Coal tar is a black somewhat viscous liquid, almost 100 percent aromatic in chemical composition and is the result of the destructive distillation of bituminous coal in coke ovens. Tars as they are known today contain some water and have an initial boiling point of about 170 C. They consist of a multitude of aromatic compounds the simplest of which is benzene. As the tar is distilled the higher boiling or higher molecular weight compounds are taken off in the form of oils, until, if the distillation is carried far enough, only carbon (pitch coke) will remain in the still. Apparently no appreciable breakdown of molecular structure occurs in the distillation until just prior to the carbon formation at vapor temperatures of about 400 C. There is no distinct differentiation between the terms "tar" and "pitch," but in general, any time a tar is distilled to remove water and a small amount of oil, the residue in the still is termed a pitch. Pitch may be somewhat fluid at room temperature or hard, brittle and have a high softening point depending on the amount of oil distilled from the tar. Rarely do any two Webster dictionaries, chemical dictionaries or encyclopedia give the same definitions for the two terms. Raw tars are rarely used for coatings because of the lighter oils distilling up to about 300 C. These are normally termed chemical oils because it is from these that the tar acids, tar bases and naphthalene are removed. They are light oils and evaporate fairly rapidly making coatings become hard and brittle. Normally in the production of those materials recognized as road tars of the less fluid grades (RT-6 to 12), the tar is distilled to a soft pitch (to about 275 to 300 C), the valuable tar acids, tar bases and naphthalene are removed from the distillate, then the distillate is added back to the pitch in the correct amount to give the desired road tar grade or viscosity. The tar bases should be removed because they are aromatic amines and react with epoxy resins. Both the tar acids and bases are slow curing agents for epoxy resins.

The use of coal tar pitch with the epoxy resins was an attempt to improve the underwater adhesion of the room temperature curing epoxy resins, to reduce their hardness and the overall cost of coatings made from them. Development of the original coating was rapid and by the middle of 1953, field applications of the coating were being made to crude oil storage tanks, oil refinery equipment, pipe joints and valves and some hand applications of the coating to short, special pipelines for underground use.

United States Patent No. 2,765,288 was issued to Pittsburgh Coke and Chemical Company October 2, 1956 covering the use and composition of this coating system. Within a comparatively short time a number of companies were licensed to produce and sell these coatings under the terms of the patent, but the license did not grant formulation help. Today there are per-



Setting the segments of the extrusion head for proper thickness before applying coating with the extrusion head.



Application of a tar-epoxy to 6-in. pipe using a stationary cleaning-priming machine with rug-type rollers.

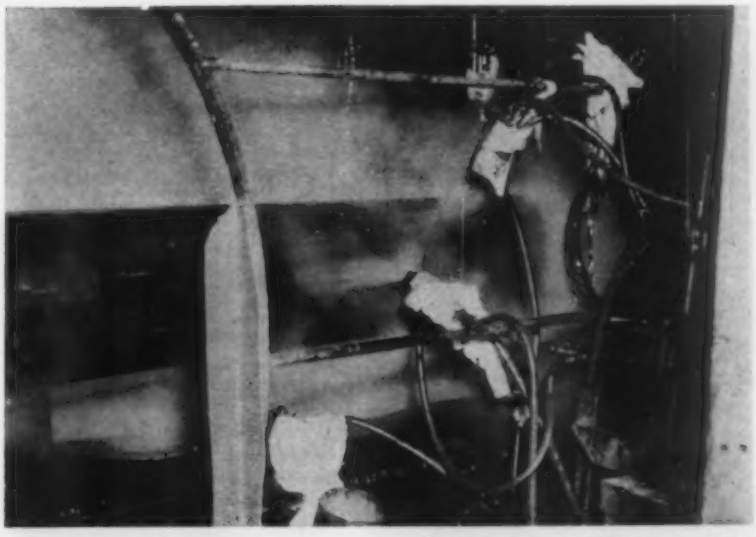
haps 20 licensed manufacturers most of whom are striving for the lucrative, large volume pipeline market.

The many two-component tar-epoxy coatings on the market vary widely in composition, curing characteristics and coating properties. The ratio of the two components by volume varies between 1:20 and 1:1; the total solids or volume conversion from wet coating film to cured film varies between 70 and 90 percent. The variations in composition are a result of the very difficult problem of proper selection of raw materials. There are a wide variety of epoxy resins, hardeners, pigments and solvents from which to select, and proper selection of each of these raw materials has a direct bearing upon the characteristics of the resultant coating. Many of the faults of these coatings can be attributed to a lack of knowledge of the coal tar pitches and the hardeners, and a lack of understanding of what is good underwater adhesion. It must be remembered that adhesion of a coating to pipe underground is the same as continuous immersion. A point often overlooked by the coating manufacturer is that once a good formulation and manufacturing process is developed, it should not be changed except after long exhaustive testing. If changes are made, the users should be advised. Many relatively new coatings on the market today (10 to 15 years old) are said to have 10 to 15 years underground service records, yet the majority of them have been radically changed in composition, hence their service records are only as long as the period of time since the last changes were made.

Some limiting factors. Good tar-epoxy coatings are not easily applied in uniform film thickness to pipe. This is true of all liquid coatings where application is in a single coat of from approximately 10 to 50 mils coating thickness range. This has been one of the major problems as well as obtaining quick firm curing of the coating film.

The question of the life of the coating is anyone's guess. Most of the estimates on long life are based on the known characteristics of the baked epoxy resin coatings and those of the hot applied coal tar coatings. Both of these products are the basic ingredients of the tar-epoxy coatings.

There is also the question of film thickness. Cost of the coating and its application limit the maximum coating thickness to about 30 mils wet. Past experience with these coatings indicates that any film thickness less than 10 mils rarely withstands continuous immersion in water, even 10 mils is the balance point. Thus, it is agreed that 15 mils coating thickness is the very minimum, and for a safety factor, it should not be less than 20 mils. Linked with film thickness is the question of clean metal. For normal production



(Photo courtesy, Coast Paint & Lacquer Co.)

One of the early conventional spray applications of tar-epoxy to hot sand blasted pipe.

of coated pipe, sand, grit or shot blasting is most economical and gives the cleanest metal surface with an anchor pattern. Here again cost enters the picture. The anchor pattern must not be deep, maximum depth one mil. Deep anchor pattern uses coating to fill the pits which does not add to the ultimate coating thickness. Coating thickness is from the peaks of the pattern to the surface of the coating.

One of the limiting factors in the application of any thin film coatings in the field and sometimes in the mill is dust, dirt, grit or sand. In the field and rail-head coating application, it is almost impossible to keep small particles of dirt, sand, grit or other foreign matter from being kicked or blown about. Since the thickness of the coating is only 20 to 30 mils, and the coating is wet and fluid for a period of time, such foreign objects get into the coating. Their diameter is such that they are only slightly smaller or may be greater in diameter than the thickness of the coating. Thus, they penetrate the coating and make a void. This is a real problem in the field and unless extreme care is exercised in mill application, the result is often many small voids in the coating on each joint of pipe. Even if slow curing of the coating were not a problem from the standpoint of space for cure and production cost, the dirt problem is critical. The fastest cure possible is essential.

Curing time of tar-epoxy coatings. Curing time of tar-epoxy coatings from different manufacturers will vary at room temperature by several hours. The variations in curing times are caused partially by the type and amount of epoxy resin used in the formulation and also by the type and amount of curing agent used. Some products on the market also increase in curing time as the unblended coating remains in storage (shelf life). This is a formulation problem that is not difficult to overcome. Another point with regard to formulation and a point over which the manufacturer has no control, is a gradual increase in viscosity in any component containing tar and epoxy resin while the coating is in storage. This is not serious as long as it is taken into consideration when the coating is applied. There is no clear explanation for this, but it is believed that there is some reaction between the epoxy resin and the tar or pitch. Regardless of this reaction it has no effect on the amount of hardener required. It is probably the reaction between the tar and the epoxy resin that makes the resultant coating film so chemically resistant.

It was previously mentioned that the tar-epoxy coatings may be cured either at room temperature or heat cured. In fact, the temperature of the metal or pipe on which they are applied has a tremendous effect on the cure time to a hard, firm coating. Table 2 gives the results of carefully controlled laboratory tests on curing time of some of the better tar-epoxy coatings. These tests were performed using lightly sand-blasted steel plates ½-in. by 4-in. by 12-in. Temperatures before and after application of the coatings were carefully controlled. The coatings were applied by a "doctor blade" in a thickness range of 20 to 24 mils. The time required for removal of the plates from the constant temperature oven, application of the coating and back into the oven was approximately 30 seconds.

TABLE 2. Approximate Cure Time Tar-Epoxy Coating at Various Temperatures.
Steel Plates ½-in. by 4-in. by 12-in.

Metal Temp., F	*Cure Time to Hard Film*	
	Hours	*Minutes*
50	42	—
75	9	—
100	3	—
125	1	50
150		55
175		30
200		20
225		9
250		5

Mill applications have fallen quite close to the values determined above. One interesting result of mill application of the coatings to pipe at temperatures above 175 F is that the pipe holds its temperature better than the plates so that no after-coating heat need be applied to obtain the same set time.

Recent Application Developments

Although much experimenting was carried on during 1957 and through part of 1958, not much new developed in application of the coatings. This earlier work did bring out some facts and point to new methods of application. It became quite evident that good methods of proportioning the two components to either a mixing head or a two-component spray gun was necessary. Feeding a thin hardener and a viscous liquid in the ratio of 1:20 was too difficult for plant control. To correct this factor some of the coating manufacturers revised their production of the coatings, maintained the same ingredients and quantities of each, but combined them into a system of equal components of approximately equal viscosities. This permits the use of two pumps feeding equivalent volumes of the components.

Odd as it may seem, the coating mills will undoubtedly go to heating the pipe to obtain fast setting of the coating. This was successful with an extrusion head and has been applied successfully with other methods of application. Heating equipment has been developed to permit the cleaned pipe to pass through the heaters to heat the pipe to a specific temperature and then through the coating equipment at rates up to 60 ft per min.

Airless spray method. Only one new method of application of the coating can be described at this time. Some time ago a newer method of spraying coatings was developed generally known as "airless spray." Previous methods of spraying depended upon air to atomize the coating at the spray nozzle. The new method uses the garden hose method of high pressure and a small orifice. Although there are several companies developing equipment of this type, the Gray Company had airless spray equipment for normal paints and has developed a special spray gun and pumps to handle the tar-epoxy coatings. The equipment consists of two high pressure pumps feeding the two components through separate high pressure hoses to a special spray gun equipped with a mixing chamber where the two components become thoroughly mixed before entering the spray nozzle. The system operates at about 2500 lb pressure and gives a perfectly smooth coating. Since the system uses no air, there is practically no over-spray. The spray guns may be set in tandem with overlapping spray pattern to coat any diameter of pipe rapidly.

Another airless spray system that was developed for the spraying of epoxy resins that may be adapted for the coal tar-epoxy resin coatings, is the Gusmer equipment. In this equipment, the two components are fed directly into the spray nozzle chamber of the gun, are mixed there, then forced through the nozzle at high pressure. In this and the Gray system the two components are heated to between 125 and 150 F to gain fluidity to permit a reduction of the pressure.

These are not the only innovations that are coming in mill application of coatings both old and new. It is these innovations that may make it possible for new synthetic or synthetic based coatings to be used at about the same cost as for the normal hot coating system of primer, enamel, saturated felt, and kraft. Some of this can be understood by comparing Fig. 1 and 2.

Coating Joints and Fittings In the Field

One of the stumbling blocks in the

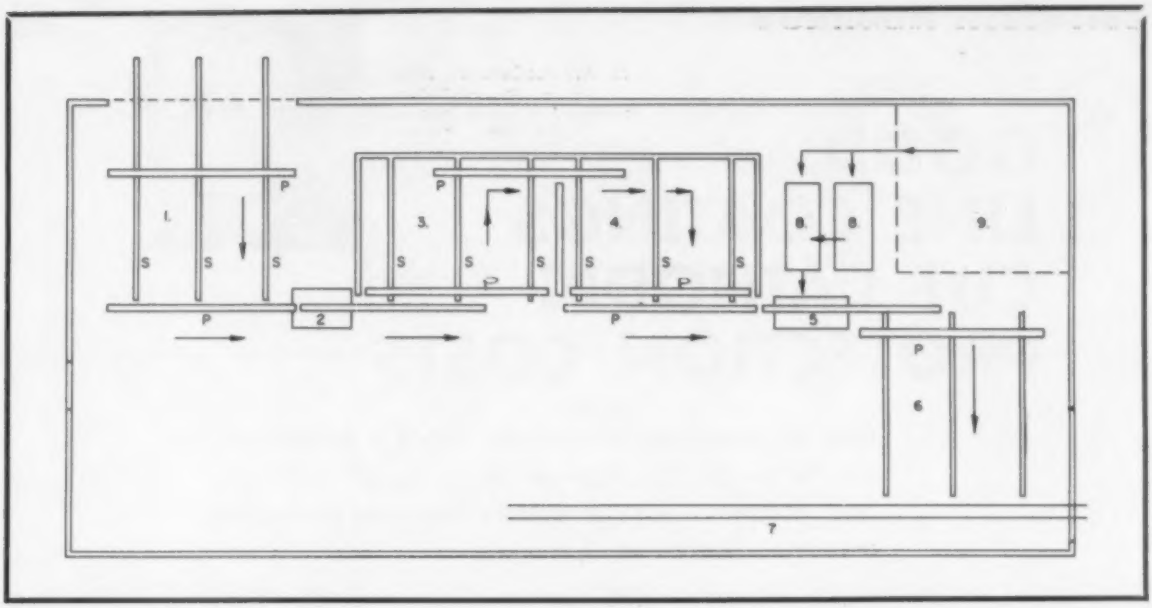


FIG. 1. A Schematic Plant Sequence for Mill Application of Hot Applied Coatings.

Walled-in Area

Legend
1. Pipe entering plant from storage or yard
2. Blast cleaning and priming
3. & 4. Heated primer drying rooms
5. Coating application
6. End cut-back and cooling skids
7. Loading track or to storage
8. Heating kettles
9. Hot coating storage
S. Skids for pipe movement
P. Pipe

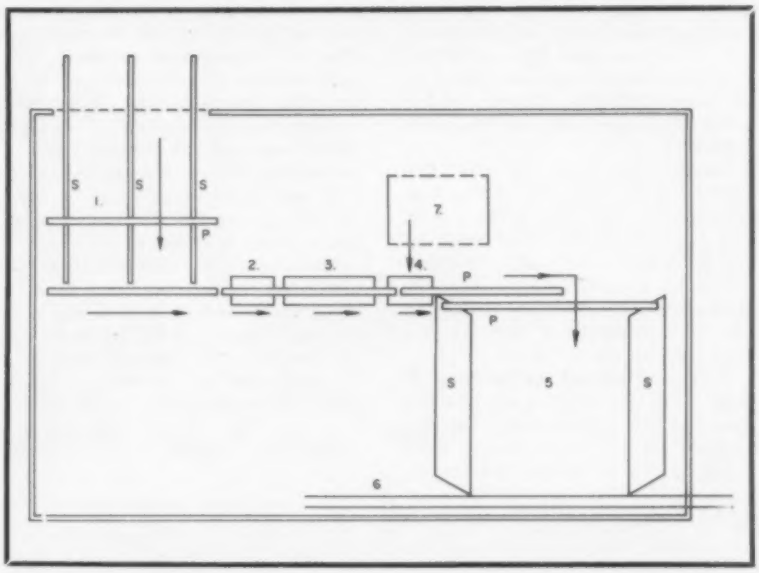


FIG. 2. A Schematic Plant Sequence for Mill Application of Tar-Epoxy Coatings.

Walled-in Area

Legend
1. Pipe entering plant from yard or storage
2. Blast cleaning
3. Pipe heater
4. Coating application
5. Cooling and curing rack
6. Loading track or to storage, coated pipe
7. Storage, drums of coating
S. Pipe skids for pipe movement
P. Pipe

coating and installation of long pipelines or utility lines has been the coating of welded joints, flanges, valves and other fittings. With the coal tar-epoxy resin coatings a new method of coating welded joints or to make repairs on damaged coating should be available within a relatively short period of time. The method utilizes a cold mix of the tar-epoxy coating but can be applied quickly and the line buried immediately without danger of "squeeze out" or danger of damage to the joint from the back-fill. The same system may be applied to other coating systems. The only coatings to which it would not adhere are polyethylene, extruded polyethylene and the waxes.

Flanges, valves and fittings having odd shape are still a problem regardless of what coating is used. Many companies are coating these in the shop or the warehouse with tar-epoxy coatings while they are in storage before going out on the line. Touch-up of damaged areas is done in the field. It is interesting to note that for those companies or utilities who frequently use couplings instead of welding the joints, the Dresser Manufacturing Division of Dresser Industries, Inc., now have couplings available that are precoated using a tar-epoxy coating as a primer and a top coating of high penetration water works coal tar enamel. These may be damaged some in installation but only on outside surfaces that are easily repaired.

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3. J. N. Hunter, Jr., "'Light Weight Pipe with Thin Film Coating for Gathering Lines," *Oil and Gas Journal*, 55 *No.* 37 *September* 16, 1957.

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Pipeline Division,
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GOOD LINE COATINGS CUT CATHODIC PROTECTION COSTS

Cost of protecting a pipeline can be minimized by the proper application of top-notch coatings and balanced with adequate cathodic protection measures. Here's an example

RECENT TREND in transmission pipeline coating specifications has been toward a single coat of coal tar or asphalt with glass-fiber reinforcement and an impregnated felt overwrap. Most plant applied coatings include an additional wrap of kraft paper, but this is not usually done on over-the-trench coatings.

Recent experience has indicated, however, that the quality of the coating buried in the ditch differs a great deal even though the same specification is used. What's more, the difference is of sufficient magnitude to be ecnomically important in connection with the application of cathodic protection to the coated pipe.

Plasticized enamel applications. In early 1958 the coating specification shown in Fig. 1 was adopted for pipe wrapped in stationary plants. Fully plasticized enamel is specified because fully plasticized enamel provides a better bond to the pipe and is much less subject to chipping and cracking. It has been common practice to specify fully plasticized enamel for installations carried out at sub-freezing temperatures since the unplasticized or semi-plasticized enamels become excessively brittle under these conditions. It is better to specify a fully plasticized enamel for general use with the limitation that it not be used for installations involving high gas temperatures or to be constructed during hot weather (say at temperatures in excess of 90 F).

Published data[1] indicates that unplasticized enamel may crack even at temperatures as high as 45 F and it is reasonable to assume that generally the *tendency* to crack under soil stress will be greater for unplasticized or semiplasticized enamel than fully plasticized enamel. It is true that the unplasticized or semiplasticized enamels have a somewhat lower penetration (ASTM D-5) than the fully plasticized enamels, but it is not felt that the difference is at all critical when the outer wrap of glass reinforced, asbestos felt is used.

Minimize handling. At the same time that the fully plasticized enamel specification was adopted, it was decided to place even more emphasis on the careful handling of coated pipe during its transportation and installation. To this end arrangements were made for the shipment of plant coated pipe by truck, directly from the coating plant to the pipeline trench, thus keeping the handling of the pipe to a minimum. Discussions with the truckers made very clear that the pipe must arrive at the trench side in the same near-perfect conditions it was received at the coating plant.

FIG. 1. Cathodic Protection of Birch Creek Pipeline Pipe Coating Specification.

Work sequence and materials for the standard plant applied pipe coating will be:

1. Steel grit blast cleaning
2. Primer coat*
3. Fully plasticized coal tar enamel**—3/32 in.
4. Glass-fiber mat
5. Coal tar enamel seal coat
6. 15-lb tar impregnated, glass reinforced asbestos felt
7. Heavy kraft paper—70-lb minimum.

*—As recommended by the supplier of the enamel.

**—220 F minimum softening point (ASTM D-36), and 4-9 penetration at 77 F (ASTM D-5).

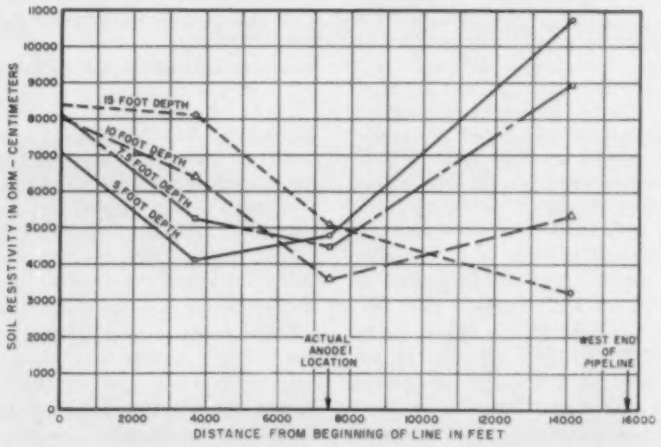

FIG. 2. Cathodic protection of Birch Creek pipeline — soil resistivities at most likely anode locations.

How One Installation Checked Out

In the example installation discussed below, the pipe was thus shipped by truck after plant coating for a distance of 1500 miles, and the results obtained were certainly very satisfactory.

As an example of the results obtained, the installation of the Birch Creek Pipeline, a relatively small natural gas pipeline in a producing field near LaBarge, Wyoming, will be discussed. This pipeline consists of 2.93 miles of 6 in. diameter, 0.135 in. wall, X-42 line pipe plant coated according to the specifications in Fig. 1 and delivered by truck to the trench side. The line was installed by company crews and the joint wrapping was done by hand using a single "cigarette" type wrap. Every effort was made to prevent damage to the coating and the entire line was checked with a holiday detector previous to lowering into the trench.

Line tested after a year. After allowing one year for the trench soil to consolidate, cathodic protection testing was carried out. Because the line was laid in dry, rocky hills with rather high resistivity soil, it was expected that a small rectifier and groundbed system would be required.

The soil resistivity tests (see Fig. 2) showed an average resistance to anode depth (5 ft) of 7100, 4100, 4800, and 10,800 ohm-centimeters respectively at the most promising anode locations or an average of 6700 ohm-centimeters. The overall average soil resistance was 6400 ohm-centimeters for readings to depths of 5, 7½, 10 and 15 ft.

Full cathodic measures not war-

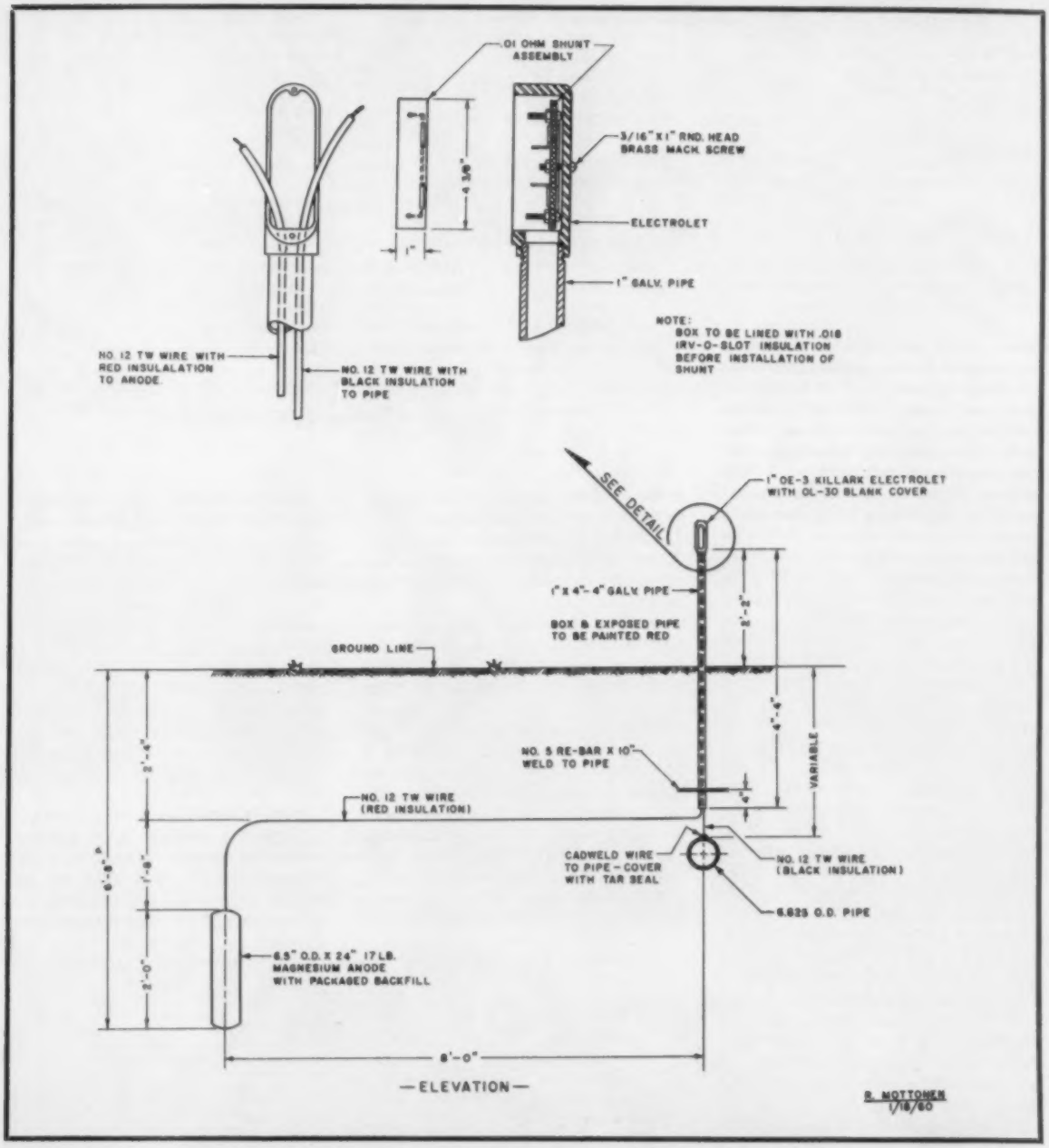
.01 OHM SHUNT ASSEMBLY
3/16" X 1" RND. HEAD BRASS MACH. SCREW
ELECTROLET
1" GALV. PIPE
NOTE: BOX TO BE LINED WITH .018 IRV-O-SLOT INSULATION BEFORE INSTALLATION OF SHUNT
NO. 12 TW WIRE WITH RED INSULALATION TO ANODE.
NO. 12 TW WIRE WITH BLACK INSULATION TO PIPE
SEE DETAIL
1" DE-3 KILLARK ELECTROLET WITH OL-30 BLANK COVER
1" X 4"-4" GALV. PIPE
BOX & EXPOSED PIPE TO BE PAINTED RED
GROUND LINE
NO. 5 RE-BAR X 10" WELD TO PIPE
VARIABLE
NO. 12 TW WIRE (RED INSULATION)
CADWELD WIRE TO PIPE - COVER WITH TAR SEAL
NO. 12 TW WIRE (BLACK INSULATION)
6.625 O.D. PIPE
6.5" O.D. X 24" 17 LB. MAGNESIUM ANODE WITH PACKAGED BACKFILL
8'-0"
— ELEVATION —
R. MOTTONER 1/18/60

FIG. 3. Cathodic protection of Birch Creek pipeline — anode installation details.

EXHIBIT A:
Cathodic Protection of Birch Creek Pipeline — Basic Calculations.

Pipeline Statistics

Pipeline length	15,470 ft
Pipe diameter (OD)	6.665 in.
Pipe wall thickness	135 mils
Pipe weight	9.29 lb
Pipe material	API 5L X-42
Pipeline depth (average)	33 in.
Pipeline surface area: unit	1.73 sq ft/ft
Total	26,750 sq ft

Anode Statistics

1 — 17-lb High Purity Magnesium Anode in Packaged Backfill

Weight of magnesium	17 lb
Soil resistance at anode	4800 ohm-centimeters

Test Statistics

Total current drainage		0.012 amps
Pipe to soil voltage*:	At anode	1.37 volts
	At east end	1.29 volts
	At west end	1.30 volts

Calculations

$$\text{Current density on pipe} = \frac{0.012}{26{,}750} \times 1000 = 0.000448 \text{ Ma/sq ft}$$

$$\text{Estimated anode life} = \frac{17 \times 125}{0.012 \times 8750} = 20 \text{ years}$$

*—Referred to copper/copper sulfate electrode.

EXHIBIT B:
Cathodic Protection of Birch Creek Pipeline Cost Calculations.*

Anode Installation

Estimated life	20 Years	
First cost	$115	
Estimated salvage value (20 years)	0	
Annual disbursements (testing)	40	
Interest on first cost at 6% = $115 (0.06)		= $ 7
Amortization (5% interest on fund) = $115 (0.03024)		= 4
Taxes at 5% = $115 (0.05)		= 6
Annual disbursements		= 40
Total annual cost		$57

Rectifier Installation

Estimated life	30 Years	
First Cost	$800	
Estimated salvage value (30 years)	50	
Annual disbursements:		
Testing	$ 40	
Renew groundbed	30	
Power	120	
Operating	60	
Total	$250	
Interest on first cost at 6% = $800 (0.06)		= $ 48
Amortization (5% interest on fund) = ($800-50) (0.01505)		= 11
Taxes at 5% = $800 (0.05)		= 40
Annual disbursements		= 250
Total annual cost		$349

*—Using sinking fund depreciation method.

ranted. From inferences in the literature supplied by the various magnesium anode manufacturers, it appeared unlikely that these conditions would be suitable for a magnesium anode installation. For example, in one case various size anodes are recommended for various soil resistivities, the highest soil resistivity listed being 3000 ohm-centimeters. In another case the maximum soil resistivity considered is 5000 ohm-centimeters. Similar limitations were indicated in certain technical books.[2]

One test anode installed. In the process of testing for the installation of the rectifier system, however, it became apparent that the coating on the pipeline was such that only a very small cathodic current would be required to obtain adequate pipe to soil potentials. As a matter of fact, the initial tests were of little use for design purposes since a welding generator had been used as a current source, and the lowest voltages obtainable gave terminal pipe to soil potentials 10 times greater than necessary. On the basis of this, it was decided to install one 17-lb high purity magnesium anode as a source of test current, and then install additional anodes as required to achieve adequate potentials.

This "test" anode was installed as shown in Fig. 3 at the approximate center of the line where the soil resistivity was 4800 ohm-centimeters. The anode only drained 12 milliamperes after initial polarization, but it raised the pipe to soil potential to 1.37 volts at the anode installation, to 1.29 volts at the eastern extremity of the pipeline and to 1.30 volts at the western extremity (all voltages referred to the copper/copper sulfate half cell). It was accordingly not necessary to install any additional anodes.

At 12 milliamps of current drainage, the unit current requirement for this pipeline is 0.000448 milliamps per sq ft of pipe surface (see Exhibit A for calculations). This current requirement is only 6 percent of the design figure of 0.0075 milliamps per sq ft commonly used for pipelines with excellent coatings. It is somewhat difficult to estimate the life of this anode installation since the current efficiency decreases sharply at low current outputs,[3] but assuming an efficiency of only 12½ percent or 125 ampere-hours per pound of magnesium gives an expected life of 20 years.

Magnesium anode installation costs were as follows:

1—17-lb anode	$ 14
Miscellaneous materials	18
Installation labor	20
Testing and engineering	47
Transportation	8
Overhead	8
Total	$115

Analysis of costs. A small rectifier and groundbed installation would conservatively cost $800 with an added operating cost for power of $10 per month or $120 per year (the minimum service charge at this location). On an annual cost basis, the anode installation costs $57 per year compared to $349 per year for the rectifier system (see Exhibit B for calculations). The annual savings of $292 was made possible in this case by the high quality of the coating on the pipeline in the trench, which made the use of a magnesium anode installation practical in spite of relatively high soil resistivities.

There are certainly many locations where savings can be realized in this manner, and the small additional cost for the best coating and the extra care in handling of the coated pipe during shipping and installation will be well repaid in reduced cathodic protection costs.

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Corrosion Roundup

Internal Sandblasting of Pipelines In Place

Frank H. Love, *Editor*

INTERNAL SANDBLASTING of pipe in place to increase flow efficiency, an operation that until now has resisted solution, is being done successfully in the Gulf Coast area of Texas. Developed by J. D. McCune, contractor of La Porte, Texas, operating under the firm name of Klean-Kote, Inc., the method has been used to clean crude oil, gas, salt water disposal, and chemical lines. Maximum pipe diameter thus far has been 8 in., but equipment is being developed for use on pipe to 20 in. diameter.

Key to successful operation is air volume. The procedure, simply stated, is to force sand suspended in an air current through a pipeline. The sand-air can be introduced at a scraper trap or cut in the line and expelled at another trap or cut. Cleaning action begins on the discharge end of the pipeline and retrogresses to the inlet end. In this way, there is no clogging of the pipe due to accumulation of loosened materials.

Maximum length of a section that can be run with present equipment is 10 miles of 8-in.

How Much Air

Pipe diameter determines the volume of air required and consequently the number of air compressors employed. For 2 and 2½-in. pipe, one compressor of 600 cu ft per min capacity is used; for 4 and 5-in., two units of the same size; for 6-in., three; and for 8-in., six. These compressors are connected through hose to the manifold of the mixing tool. In addition, a single compressor is connected to the sand pot to provide sufficient air to start turbulence and effect transference of sand to the mixing tool. Discharge from the mixing tool also is through a hose, which is coupled to the pipeline to be sandblasted. Volumes of air and sand into and out of the mixer are regulated by means of valves. Because of the abrasive quality of the sand, spare sand pots and mixers are available for replacement when repairs or adjustments are needed.

All equipment, compressors, sand pot, and mixer, is either trailer mounted or equipped with wheels to make it mobile.

New Equipment . . . More Air

Contrary to what would seem logical, pressure requirements are small. As previously stated, the extent of the operation . . . maximum diameter of pipe and length of section . . . depends upon free air or air volume, which is calibrated or determined mathematically. Upon this fact hinges the extent to which the procedure can be developed. The goal is to design equipment that can clean pipe to and including 20 in. diameter and in sections to 10 miles in length. To accomplish this gas turbines and blowers currently are in course of construction to provide the greater volume of air.

The gas turbine will have the feature of providing more air than present equipment while being lighter in weight. The unit under development by a leading turbine manufacturer will have a capacity of 2800 cu ft per min, and will weight only 365 lb. This is light enough that it could be carried by hand, but it will be mounted on a trailer, making it compact and mobile.

The blower type machine, which is being developed by a prominent maker of this kind of equipment, will provide greater air volume than the turbine, but will not be nearly so light in weight. It will have a capacity of 5000 cu ft per min and will weigh approximately 10,000 lb. However, it will be trailer mounted and thus reasonably mobile.

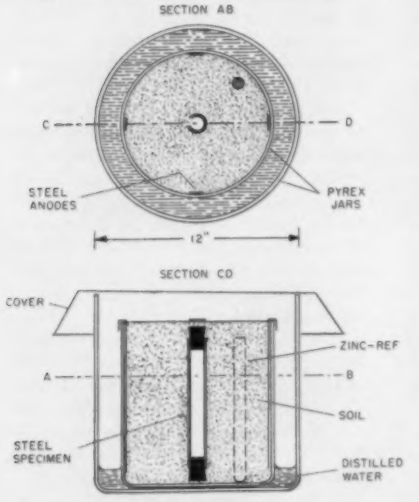
A secondary but attractive phase of this method of cleaning is the short period of time that a line is out of service while being cleaned. As an example, one 8-in. line 3½ miles long was cleaned in 3 hours. Nor apparently does the condition of the pipe affect the ability to clean, as some lines sandblasted have had 90 percent restricted flow, according to McCune. ★ ★ ★

J. D. McCune . . . he developed the method.

Closeup of mixing tool and sand pot showing hose connections to each other and to air compressor.

Equipment used to sandblast pipe internally and in place. Sand pot is mounted on truck; mixing tool in background, and air compressors encircling.

FIG. 1. Cross-sectional views of the experimental arrangement used at the National Bureau of Standards for exposing a steel specimen to a low-resistivity soil. The experiment was conducted to determine the electric potential necessary for giving cathodic protection against corrosion.



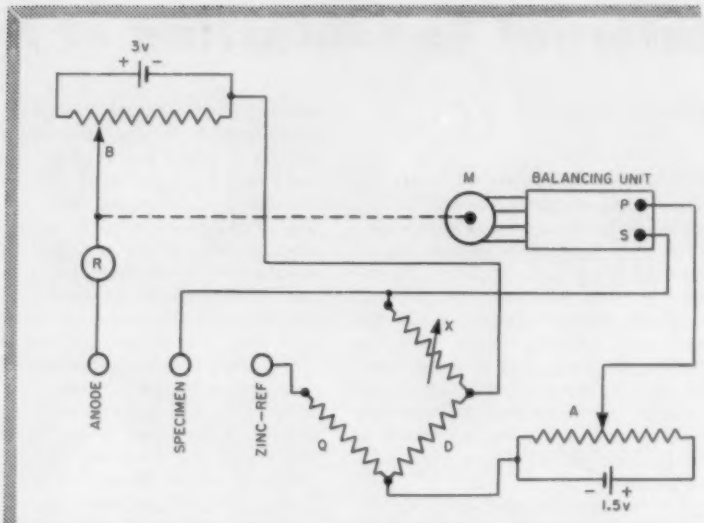


FIG. 2. One of the circuits used for investigating the cathodic protection of steel in high-resistivity environments. This circuit utilizes a bridge for balancing out the IR drop between the specimen and the reference electrode, as well as an electronic balancing unit for controlling the potential of the specimen.

NEW DATA ON...

Cathodic Protection in High-Resistivity Soil

Bureau of Standards finds potential of —0.77 volt also gives highest degree of protection in high-resistivity soil, as it does in soils of low resistivity

A POTENTIAL of −0.77 volt, previously shown to protect steel cathodically against corrosion in low-resistivity environments,[1] also afforded the highest degree of protection in a high-resistivity soil, according to a recent National Bureau of Standards experiment. This potential, referred to a saturated calomel electrode, is equivalent to −0.85 volt referred to a copper-copper sulfate electrode.

In the present study it was found that the best results were achieved when IR (voltage) drop between the reference electrode and the metal, caused by the protective current, was excluded from potential measurements.[2]

As the underground corrosion of iron or steel is mainly an electrochemical phenomenon, the electric potential at which a metal structure should be held to prevent the destructive process is of practical importance. Insufficient potential will give inadequate protection. On the other hand, maintaining a greater potential than is needed represents wasted electric energy.

Earlier studies of cathodic protection at the Bureau were conducted with soils and water having resistivities of less than 1000 ohm-cm. In these environments, measured potentials were virtually free of IR drop. In high-resistivity environments, however, measured potentials made on underground structures often include considerable IR drop as well as polarization voltage. W. J. Schwerdtfeger, of the Bureau's corrosion laboratory, undertook the present study to find out whether this IR drop, which under some circumstances has theoretical value, is beneficial under practical conditions, for example, in potential measurements made on pipelines. Also evaluated with respect to a high-resistivity environment were polarization techniques, formerly used successfully to determine the amount of external current necessary to give protection.

The Experiment:

For the experiment, five specimens, 8 in. long, were cut from one piece of cold-drawn steel tubing (1 in. OD) and treated to confine corrosion to the outside surfaces. A sandy loam soil, having a resistivity of about 20,000 ohm-cm, was the corrosive medium. The specimens were completely surrounded with the soil and held individually in cylindrical jars, which were placed inside larger covered jars containing enough distilled water to create a saturated atmosphere. Electric connections were attached to the specimens and to a high-purity zinc rod exposed with each specimen as a reference electrode.

A circuit was designed for maintaining one specimen at a protective po-

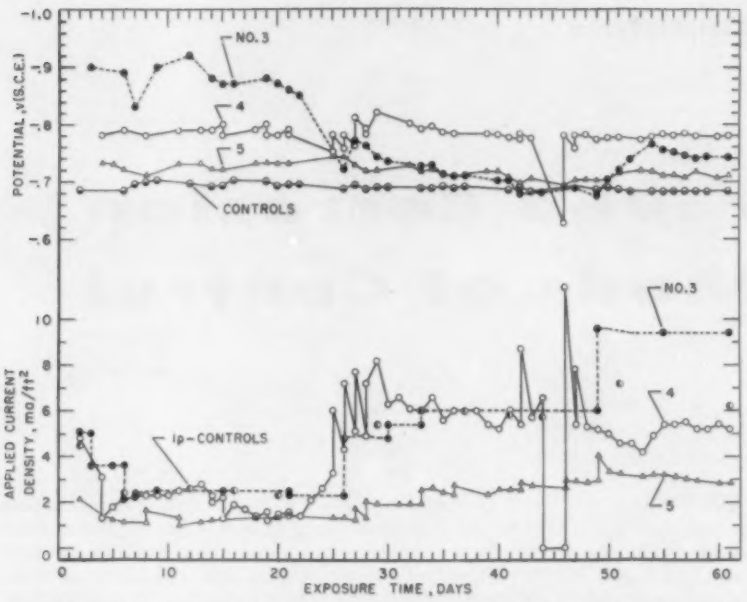


FIG. 3. Recorded variation of potential and applied current density for three specimens, with protective current requirement (Ip) shown for the two controls. It will be noted that for the first 49 days the constant current of No. 3 specimen is made to conform with Ip. The variable current required for No. 4 specimen is based on controlled potential (no IR), and for No. 5 specimen, on controlled potential, including IR drop.

tential free of IR drop. It utilized both a bridge for balancing out the IR drop between the specimen and the zinc rod, and an electronic balancing unit for controlling the potential of the specimen. A similar circuit was employed, in conjunction with a synchronously driven voltage divider and a two-pen recorder, for automatically obtaining polarization curves on all of the specimens.

Two of the specimens were without cathodic protection, serving as controls, whereas the other three had currents applied during a 61-day exposure period. The current to the third specimen was adjusted in accordance with mean values of current from cathodic polarization curves obtained on the two control specimens. The potential on the fourth specimen was maintained at –0.77 volt, free of IR drop, and on the fifth, at –0.77 volt, including IR drop.

The current applied to the specimen held at –0.77 volt, free of IR drop, was continuously recorded. Potentials between specimens and zinc electrodes, including IR drop caused by applied current, were measured almost daily, followed by measurements of the same potentials, without IR drop. Finally, after potentials of the zinc rods were measured with reference to a saturated calomel electrode, the specimen potentials were converted to the saturated calomel scale and adjustments were made, if necessary, on the control potentiometers.

The Results:

An analysis of the results showed that the specimen held at –0.77 volt, without IR drop, lost the least weight from corrosion during the exposure period. The other two specimens were protected to a lesser degree because of insufficient polarization. Thus, the experiments indicate that the highest degree of cathodic protection is achieved when IR drop caused by the protective current is balanced out. In fact, the data show that IR drop included in the potential reading can be very misleading, especially in a high-resistivity soil, and that any indication of protection contributed by IR drop should be viewed with caution.

As in previous studies, it was found that cathodic polarization curves are a reliable means for measuring the current required for cathodic protection. Applied current density indicated by the break (change-in-slope) in the cathodic polarization curve agreed quite well with the actual current density found necessary to maintain polarization at –0.77 volt, free of IR drop. The current required for protection was approximately three times the magnitude of the corrosion current.

[1] "Potential and Current Requirements for the Cathodic Protection of Steels in Soils," by W. J. Schwerdtfeger and O. N. McDorman, *J. Research NBS, 47*, 104 (1951) and *Corrosion 8*, 391 (1952); "Current and Potential Relations for the Cathodic Protection of Steel in Salt Water," by W. J. Schwerdtfeger, *J. Research NBS 60*, 153 (1958), and *Corrosion, 14*, 446t (1958).

[2] For further technical details, see "Current and Potential Relations for the Cathodic Protection of Steel in a High Resistivity Environment", by W. J. Schwerdtfeger, *J. Research NBS 63C*, 37 (1959). ★ ★ ★

Use of gas turbine engines in sandblasting pipelines internally and in place were demonstrated recently at Wallisville, Texas, by Klean-Kote Company. (See article page D-27.) A 2½-mile, 6-in. gas line was utilized for the demonstration. Power plant was an AiResearch Model 105 gas turbine compressor that produced 2400 cu ft per min of free air. The turbine itself weighed 365 lb, and with trailer and casement only 2500 lb. Compressed air for the turbine, center in photo, was cooled by a fan and heat exchanger, left, before being mixed with sand. Inset shows the type of turbine used. *(Photos courtesy The Garrett Corporation.)*

Underground Corrosion and Methods of Control

PART 3

O. C. Mudd, *Consulting Engineer, Alpine, Texas*

METHODS OF CORROSION DETECTION

Electrochemical cells associated with corroding pipe, or other underground metallic structures, result in current flow in the structure and through the soil. The measurement of potential gradients, potential differences, or current flow can be applied in determining some of the cell components and their energy origin.

Current flow potential gradients in buried pipe metal can be measured with suitable instruments between two separate points of contact on the pipe surface (Fig. 6A). The direction of current flow and potential differences between contact points can be determined. With the pipe resistance known, the amount of current flow can be calculated from the formula of $IR = E$ where:

I = current in amps
R = resistance in ohms between contact points
E = volts between contact points

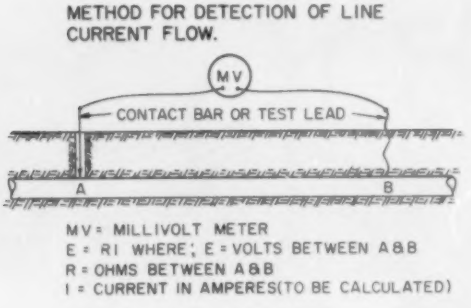

METHOD FOR DETECTION OF LINE CURRENT FLOW.
MV
CONTACT BAR OR TEST LEAD
A
B
MV = MILLIVOLT METER
E = RI WHERE; E = VOLTS BETWEEN A&B
R = OHMS BETWEEN A&B
I = CURRENT IN AMPERES(TO BE CALCULATED)
METHOD FOR PIPE RESISTANCE DETERMINATION
A
MV
C
A
B
D
A - AMMETER
MEASURED CURRENT FROM BATTERY AND VOLTAGE DROP BETWEEN A&B ALLOWS CALCULATION OF R.
C TO A AND B TO D NOT LESS THAN 5 PIPE DIAMETERS.

FIG. 6. Line current measurement.

If the resistance of the pipe is unknown, or in cases where variations of resistance may occur from pipe fittings or other sources, a counter current may be impressed on the pipe through contacts made beyond each end of the gradient measuring section, and when this counter or opposite flowing current reduces the originally observed potential gradient to zero, then the counter current equals that current causing the initial gradient observed.

Pipe resistance may be determined by the above method; however, it is preferable to impress a calibrating current of several amperes to give a more accurate potential gradient reading and then reverse the current flow for a second potential gradient reading, averaging these two potential gradient readings, thus eliminating any error from potential gradients caused by existing current in the pipe (Fig. 6B).

Potential gradient observations at successive locations along a line allow determination of current gain or loss, and those sections in which loss occurs indicates corroding pipe or possible contact with other underground structures.

Determination of current flow in pipe is not as feasible in corrosion detection as some other methods and is not desirable when coating has to be damaged in making contact.

Current from the corroding anode surface flows to the cathode areas via the soil, which has a much higher resistance than the metallic pipe connecting these electrode surfaces, hence soil voltage gradients are more easily detected, and such gradients can be measured, by contacting the soil surface over the line with suitable electrodes.

Because current flow is from a point of positive polarity to that of negative (or may be considered as less positive) it is obvious that any surface contact point above a pipe that is more positive than nearby adjacent surface contact points indicates current flow from pipe to soil directly below (Fig. 7A).

Usually it is possible to determine whether these anodic areas originate from externally imposed current (stray) or from galvanic cells associated with the pipe surface.

Potential differences between, or gradients measured along, components of electrolytic and galvanic cells show some definite characteristics.

Potential differences between the anode and electrolyte obtained by making one contact direct to the anode metal and the other by contacting the electrolyte near the anode surface will indicate:

1. The anode is positive to the electrolyte, in an electrolytic cell, as the potential causing current flow originates at the positive terminal of an external energy source (Fig. 7B).

2. The anode in a galvanic cell is negative to the elec-

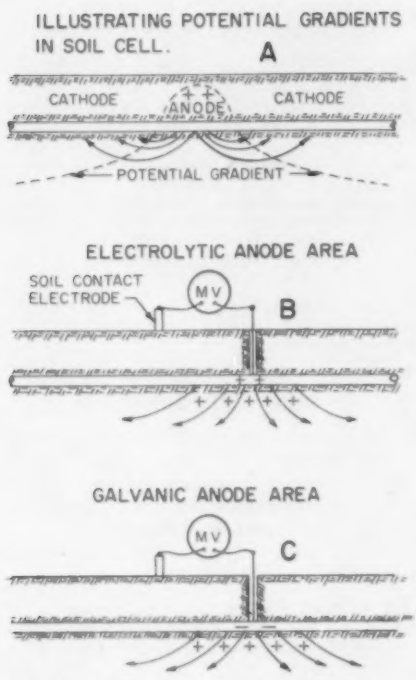


FIG. 7. Potentials in soil cells.

trolyte, being more noticeable when the metal conductor between cathode and anode has less resistance than the electrolytic path (Fig. 7C). This anode metal measures negative to the electrolyte because the energy source is at the anode surface, hence the interior metal up to this surface is the conductor connected to the negative terminal of this energy source. In pipe this conductor resistance is normally a small fraction of the electrolytic path resistance.

Potential gradients between electrode contacts at the electrolyte surface along the current path will show only the direction of current flow in an electrolytic or galvanic cell electrolyte; however, the sum of any gradient measurements exceeding normal galvanic cell voltages will be indicative of an electrolytic cell.

Potential differences between the electrolyte and cathode metal will indicate the electrolyte as positive to the cathode and the determination of the cell type involved is not readily resolved.

From the above it can be visualized that corrosion along buried pipe may be detected when measurements between different contact points of the associated electrolyte show potential differences. These points of contact made at intervals of 10 or 15 pipe diameters along the surface directly over the pipe detect a large portion of the active corroding areas; however, as pipe diameters increase there is a likely corresponding increase of corrosion cells where current flows between bottom and top in a vertical plane, and this type of flow is not easily detected except by ingenious methods that evolve with experience in each locality.

Measurements made between surface contact points at regular intervals of 100 to 200 ft along and directly over a line (surface potential survey) will indicate the general corrosion activity, and the graphic plotting of results allows appraisal of those locations needing preventive measures.

Surface potential surveys are enhanced in value by including soil resistivity measurements along with these observed surface potentials. Three or four resistivity observations spaced equidistant between surface potential contacts allow approximation of electrolyte current flow consequent with the observed potentials, and also detect variations and magnitude in soil chemical concentration. These resistivity determinations should be made for the soil just below pipe depth and in a manner that will minimize errors incurred from the pipe metal and trench backfill. Graphic records should include the highest and lowest resistivities observed between surface potential contact points.

Surface potential surveys are practical only when the potential gradients or differences originate from corroding pipe, hence any stray currents, particularly of a varying nature as those from electric railways, may preclude the use of this method.

Proper procedures in surface potential surveying reveals errors when encountered. An initial measurement is observed for the potential between pipe and soil, placing the soil contact electrode directly over the line, at the starting point, and contact the line in the vicinity.

This observed potential establishes an electrical "bench mark" equivalent to that used in land surveying.

Leaving the original surface contact electrode in place a second one is placed at the desired interval, over the line, in the direction of progress, and the potential difference with polarity recorded.

If the initial electrode is positive polarity, then the indicated direction of current flow is toward the second electrode, or equivalent to "downhill" in land surveying, hence the observed potential difference is subtracted from the "bench mark" reading. If the original electrode location is negative to the second then the potential difference is "up hill" and must be added (Fig. 8).

Each reading is added to or subtracted from the preceding result until a pipe-to-soil measurement is repeated using this last surface contact for the observation. The observed and calculated values should be in agreement, or very nearly so, if sources of error are absent.

Contacting electrodes may introduce error by their being electrically different, but the error can be cancelled by alternating electrodes with each observation.

Stray currents of low magnitude, without variations, such as that from cathodic protection units, cause errors and these are usually detected by observing a fairly consistent increase or decrease between the observed and calculated pipe-to-soil potentials.

Severe magnetic storms (associated with sun spots, or ionosphere disturbances) cause current flow on pipelines varying in magnitude and direction, which often obscure corrosion cell currents, thus rendering survey data useless.

These magnetic storms vary in duration from a few hours to several days and usually are detected by variations in readings taken a few minutes apart at the same location. A millivolt recorder connected for pipe potential gradient, or connected between pipe and soil, using a large area contact electrode, will record magnetic storm activity and show when such activity ceases.

The near ideal method of corrosion surveying as discussed above would include such devices and items of equipment as would allow a fair rate of traverse along the surface over a buried line to obtain a continuous graphic record of potential gradients and resistivities, but this is not presently practical with existing equipment and the type of terrain frequently encountered adds further complications.

The Pearson pipe coating holiday detector is an adaptation of surface potential surveying. This instrument utilizes a low frequency alternating current to obtain potential gradients and this alternating current eliminates some errors encountered when direct current is used with moving soil contacts.

Items of equipment for corrosion investigation, or control, may vary with problems encountered; however, these

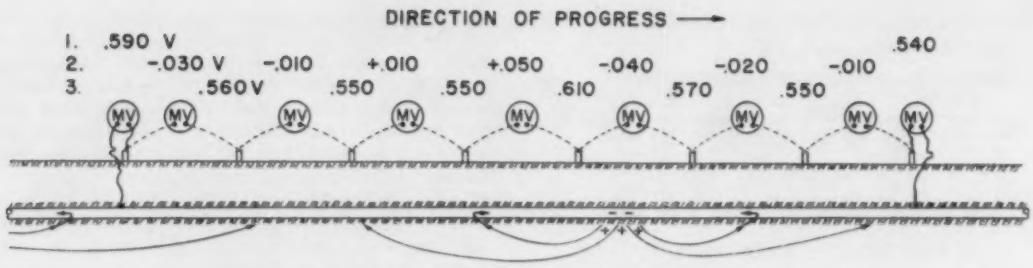


FIG. 8. Soil surface potential surveying.
Line 1. Pipe-to-soil potential using copper sulfate half cell electrode.
Line 2. Electrode-to-electrode surface potential and polarity.
Line 3. Calculated pipe-to-soil potential at electrode location.

items should be kept to the minimum essential to obtain the desired results.

CORROSION CONTROL

Basic requirement of corrosion control is to prevent metallic ion escape to the surrounding electrolyte, and all buried structures are exposed to an electrolyte when the metal surface contacts soil containing any degree of moisture. Absence of moisture precludes electrolytic corrosion.

Cases of severe corrosion and pipe penetration have been observed in extremely arid sections where rocky backfill left these corroded areas without soil contact and apparently dry. This corrosion was discovered to have originated from a high chemical content dust deposited on the pipe surface during construction and possibly later during line operations. Low temperature commodities transported through the pipe caused moisture condensation on the pipe surface, starting corrosion under these dust deposits, and thereafter the corrosion products continued extraction of moisture from the adjacent air. This is cited only as a rare circumstance of corrosion to illustrate how corrosion can occur when casual observations might result in the conclusion that corrosion would not occur.

Corrosion prevention is accomplished only when the applied methods are effective in excluding moisture from the metal surface, or when an electrical current flow from the electrolyte maintains a negative potential difference at the metal surface exceeding the galvanic potential of reaction for that metal in the environment.

The present general practices of corrosion control within economic limits include:

1. Coatings
2. Cathodic electrical protection.

COATINGS

Present and past materials applied as buried structure coatings are too numerous for discussion here; however, past experience has demonstrated some basic requirements for effective coating materials.

The most essential requirements dictated by past experience are:

1. Reasonable cost of material and its application.
2. Good electrical insulation having low moisture penetration rate.
3. Resistant to cold flow and pressure point penetration.
4. Resistance to mechanical and thermal shock.
5. Effective bond to metal surface.
6. Measures insuring coating preservation.
7. Caution in using new products.

COST OF COATING

The first fundamental of cost is to obtain the most effective material available with reasonable assurance of a service life equaling or exceeding the expected economic structure life, or in more explicit terms, the least coating cost per year of the expected economic life.

Numerous other factors enter into the applied cost and some of these are:

1. Transportation cost to application site.
2. Amount of equipment required to apply.
3. Hazards of application.
4. Cost of metal surface preparation.
5. Normal rate of application.
6. Cost of inspection to assure effective coating.

Transportation cost is an increasing factor in pipeline coating and any reduction in the weight of materials shipped to obtain equivalent results will effect savings.

Any reduction in equipment for application lowers application cost and may reduce application time.

Metal surface preparation varies with the type of coating applied. Basically this preparation should not only remove all foreign substance, but also remove all metal surface moisture if effective coating is to be obtained. This moisture removal can be accomplished by chemical methods in combination with the necessary mechanical cleaning operations, and this chemical treatment may reduce the amount of mechanical cleaning required and also result in a better coating.

The normal rate of applying coating may be affected by the material or by the application equipment or both. Thus it is advisable to obtain a favorable combination of material and machine.

Inspection is part of the application cost, which will vary according to the results sought and the capability of those delegated as inspectors. The latter is most important because inspection is not effective unless the person has had enough experience to know when applications are good or poor, and, if poor, authority is delegated to enforce any corrections necessary to obtain good application.

Higher cost of inspection by well qualified personnel, compared with that of low cost inspection by inexperienced personnel, will result in lower cost for installing electrical protection and lower continuing power requirements, justifying the additional inspection cost.

Coating costs may be increased when the marketer or manufacturer fails to meet delivery schedule or maintain specified quality, hence it is advisable to be assured of adequate delivery capacity and quality control prior to any commitment.

(To be continued in an early issue.)

Construction crews average 1.86 miles per working day through the flat sandy terrain of the hot desert.

SOPEG's 24-in. Crude Line Crosses French Sahara

First stage of 410-mile $106 million pipeline now flowing 100,000 bbl per day; ultimate capacity by 1961 is 300,000 bbl daily. This is one of three French major pipeline systems for the oil-rich Sahara

IN LITTLE more than three years after the original discovery of oil in the Algeria/Sahara Desert of North Africa, an aggressive and determined French pipeline company pushed a 24-in. line from the Hassi-Messaoud field 410 miles northward to the port of Bougie on the Mediterranean Coast. Societe Petroliere de Gerance (SOPEG) fought against almost unsurmountable odds in this difficult construction project. Not only were logistics formidable, but the extreme heat of the desert (reaching 120 F at mid-day) and unusually high winds which generated cutting sand storms delayed construction operations. Trucking all of the heavy equipment across mountains and burning deserts challenged the best the French pipeliners could assemble.

In the fall of 1959, the line was dedicated upon completion of the first of three distinct stages of construction. The main departure terminus of the line is just north of the giant Hassi-Messaoud oil field discovered in June 1956, at a depth of 11,000 ft. This large petroleum reservoir now has over 50 producing oil wells with a producing capacity of several thousand barrels each per day. A conservative estimate indicates that the total proved reserves today is 4 million bbl from this one field only.

Two French petroleum companies developed the giant Hassi-Messaoud oil field. Compagnie Francaise des Petroles (Algerie) abbreviated as CFP (A) and Societe Nationale de Recherche et d'Exploitation des Petroles en Algerie, better known as S. N. REPAL have adjoining concessions which almost cut the field in half. S. N. REPAL has the south concession; CFP (A) has the north concession.

Initial estimates indicated the desirability to build a pipeline to make oil available to the French Government. The two exploration companies jointly organized SOPEG for the purpose of designing and constructing and operating this pipeline system. The ultimate cost was to be $106,000,000 and would include three intermediate pump stations in addition to the terminus station at Hassi-Messaoud.

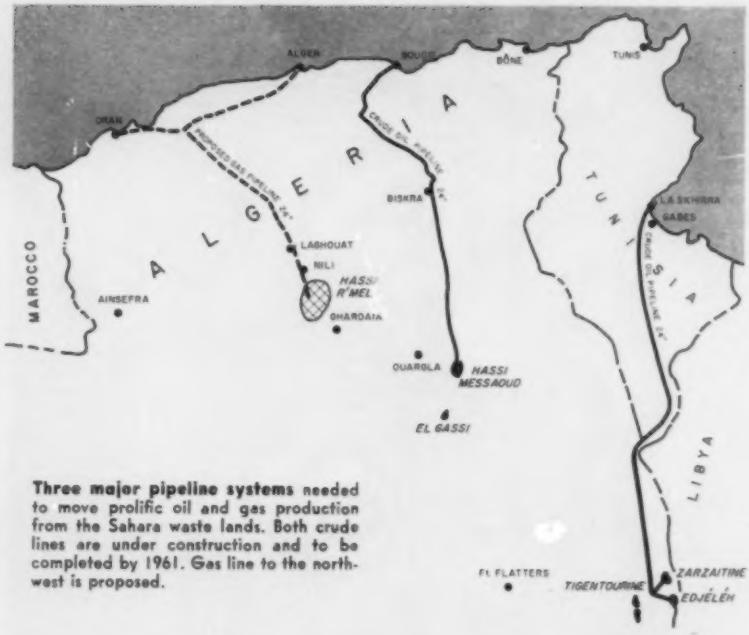
Early means of moving oil. Shortly after the discovery and drilling of additional wells to prove the reservoir, it was apparent to the two companies involved that sufficient oil had been discovered to justify pipeline construction. In fact, it was urgent that movement of oil production be expedited as soon as possible. Realizing that a complete system would take time, a temporary pipe-

line was designed to meet the best method of early oil movement. This was a 6-in. line which extended from the heart of Hassi-Messaoud for 100 miles north to the railroad point of Touggourt. From this point, oil was loaded into tank cars and moved by railroad to the Mediterranean Coast where it was loaded into tankers.

At the time the decision to build a pipeline was made by the two concession-holders (CFP (A) and S. N. REPAL) in late 1957, only an approximation of the oil field reserves could be made. For this reason, the entire project was planned in such a way that a step-by-step program for construction had to be developed in conjunction with development of the field, while at the same time minimizing large investments. Little was known about the topography, and no accurate maps were available of the heretofore little-used wastelands of the Sahara Desert and the Atlas Mountains to the north bordering the Mediterranean Coast of Algeria. There was only a trail in the early years of exploration from the Hassi-Messaoud field north. There was the problem of surveying the entire terrain to the north to select the best route for this major pipeline. Nearly 250 miles of the line crosses rather flat and monotonous sand terrain and posed no real problem in the survey other than the extreme working conditions encountered by the crews. However, the problem of making a survey through the Atlas Mountains to the north did prove to be an obstacle in accurately mapping elevations and accurately locating peaks and valleys.

Project planned in three stages. In an attempt to coordinate line capacity with development of the field, as well as take into consideration obstacles in construction and financial investment problems, three separate stages of construction were planned. The first stage, which was recently completed, included the departure terminus station in the north end of the Hassi-Messaoud oil field. It also included one intermediate pump station at M'Sila a little over 300 miles from the originating point at Hassi-Messaoud. From the terminus point to the highest elevation at Seltna, the line was to be 24 in. in diameter. Beyond Seltna sloping downward to the seaport of Bougie on the Mediterranean Coast, the line was 22 in. in diameter. The first stage also included the construction of the terminal at the port of Bougie where partial storage was provided for oil received.

The second stage was to include a third pump station 218 miles from the departure terminal at Haoud-El-Hamra in the northern part of Hassi-Messaoud. The first stage of construction



Three major pipeline systems needed to move prolific oil and gas production from the Sahara waste lands. Both crude lines are under construction and to be completed by 1961. Gas line to the northwest is proposed.

would provide a throughput capacity of approximately 100,000 bbl daily. Addition of the third station 4½ miles northwest of Biskra would increase the line's capacity to 200,000 bbl per day.

The third stage of construction would include a fourth pump station 118 miles from the departure terminal at Haoud-El-Hamra to increase the pipeline's capacity to its ultimate of about 300,000 bbl daily.

First stage of construction was finished by the end of 1959. Completion of the second stage is scheduled for April 1960, and the third and final stage is scheduled for completion by July 1961.

Discovery Briefs on French Sahara Oil

In January 1956, S. N. REPAL started drilling its eighth Sahara wildcat on the Oued Mya concession. This wildcat was given the name Hassi-Messaoud which means the "blessed well" and was the name of an old camel's water well located nearby. On June 13, 1956, the well reached a depth of approximately 11,000 ft to penetrate an oil-saturated sandstone. Original production tests indicated high bottom-hole pressure, relatively high gravity, and the oil was virtually sulfur-free. In January 1957 CFP (A) spudded a well about five miles to the north of Hassi-Messaoud No. 1 on its Ouargla concession. At the same time, S. N. REPAL moved its rig southwestward to drill the second well on the structure. In May of that year, both wells found oil-rich formations to prove that the original discovery was of major importance. Hassi-Messaoud has since been classified by its extent and its reserves among the major oil fields of the world. The 100-mile, 6-in. line to the rail center of Touggourt moved the first oil to the port of Philippeville on January 11, 1958.

Route of the Pipeline

Route of this 24-in. line across the Sahara from Hassi-Messaoud is almost a straight line joining Haoud-El-Hamra to Biskra (see map). The route passes directly to the west of the Touggourt-Biskra route of the temporary 6-in. line and avoids the salt lagoons which are very extensive in the region of M'Raier-Touggourt.

At Biskra, the route parallels the road and railroad tracks to the point of El-Outaya, and then heads west to avoid the salt lagoon of El Hodna. From M'Sila, the line crosses the mountains of Hodna at the peak of Seltna and then follows the valley down to the Mediterranean port at Bougie.

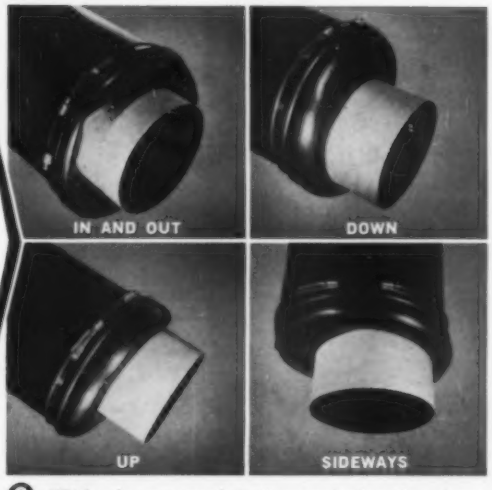
Design indicated that maximum pressure permitted was about 1100 psi and that 310 miles of 24-in. line would separate the departure terminal at Hassi-Messaoud from the pump station at M'Sila, the first intermediate station installed under the first stage of construction.

Diameter of the line is reduced to 22 in. from the peak of Seltna to Bougie since there was available considerable

NEWS FROM DOWN THE LINE!

A NEW VERSATILE AND ECONOMICAL SEAL FOR CASED CROSSINGS...

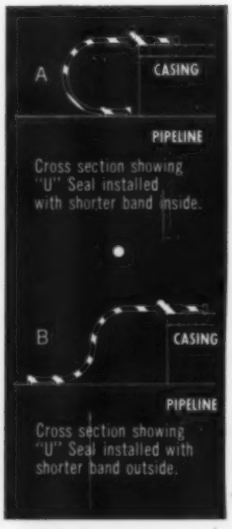
THE NEW WmSON "U" SEAL



❶ "This new WmSon "U"-Seal maintains a tight seal regardless of what position the drag section assumes inside the casing."

❷ "This is a special demonstrator to show the flexibility of the "U"-Seal. Notice how it maintains its seal regardless of the change in pipe position in relation to the casing."

❸ " . . . Here the "U"-Seal is shown installed in the new "U" shape with the shorter band inside , which allows extreme flexibility. The "U"-Seal can also be installed with the shorter band on the outside in WmSon's familiar "Z" shape. In either case, only a screwdriver is needed to tighten the two stainless steel bands."



❹ Regardless of which way you install the "U"-Seal (Fig. A or fig. B) . . . . Regardless of what position the drag section assumes . . .

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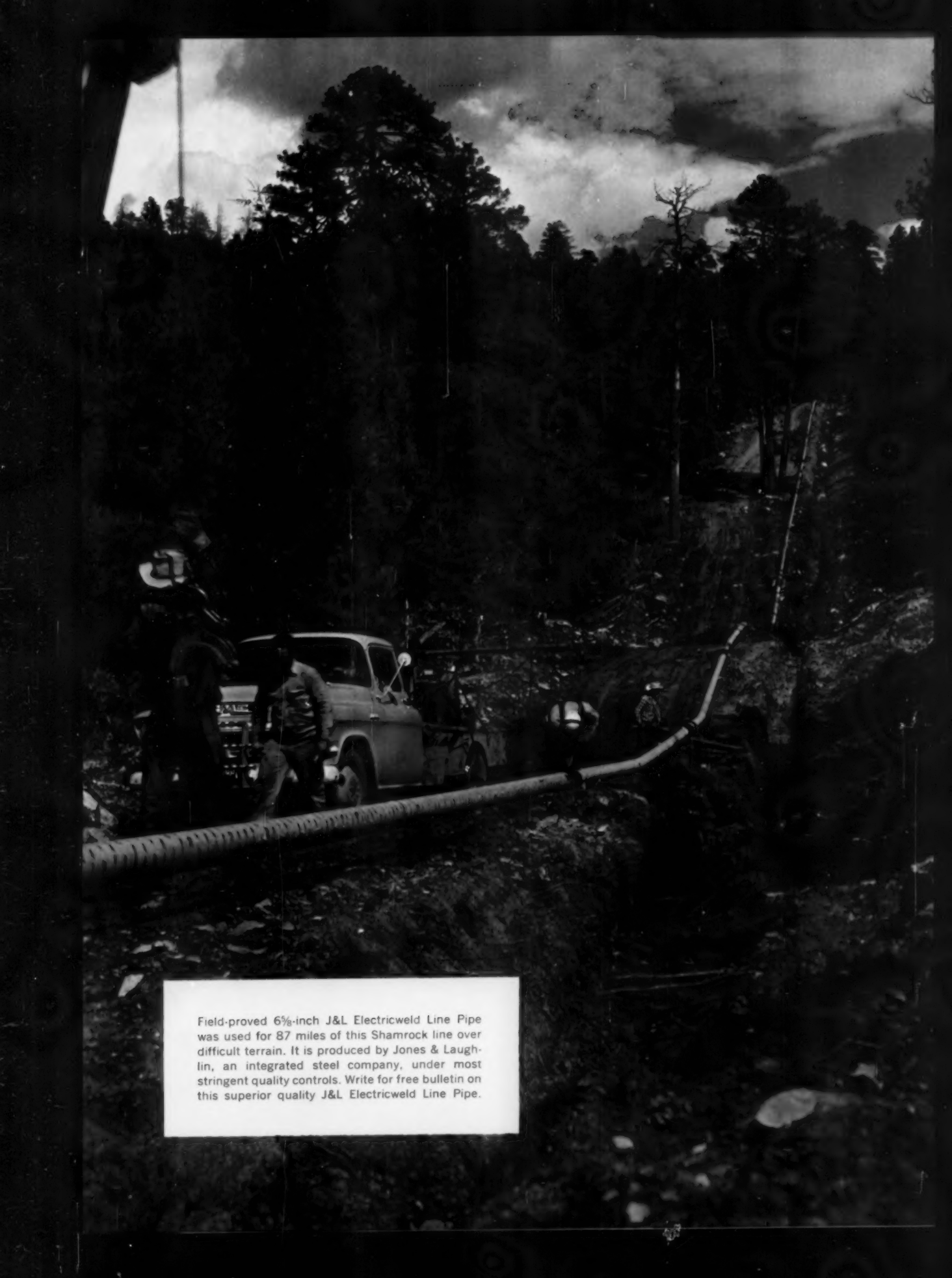
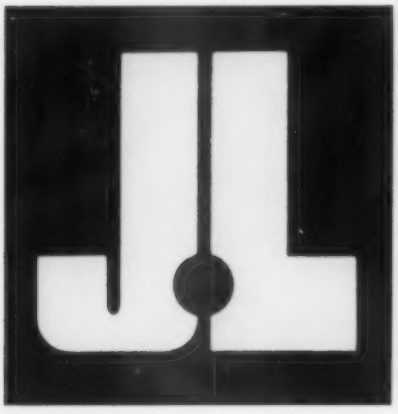


Field-proved 6⅝-inch J&L Electricweld Line Pipe was used for 87 miles of this Shamrock line over difficult terrain. It is produced by Jones & Laughlin, an integrated steel company, under most stringent quality controls. Write for free bulletin on this superior quality J&L Electricweld Line Pipe.

New six-inch products line will be operated by Shamrock for its affiliate, West Emerald Pipe Line Corporation.

Welders on this Shamrock line reported that J&L Electricweld Line Pipe was uniformly round, easy to weld.

Pipe is produced under strict compliance with appropriate A.P.I. and A.S.T.M. specifications.



Contractors for the rugged section from Palma, N.M., to Albuquerque were Groninger & King, Pampa, Texas.

Pipe is A.P.I. Standard 5 LX, Grade X 42, 12.89 pounds per foot, with a .188 inch wall thickness.

"Superior weldability of J&L Electricweld Line Pipe was proved on this mountainous operation"

. . . reports pipe line contractor

Steep, mountainous terrain presented a real challenge to pipeliners working on this Shamrock Oil and Gas Corporation line from Amarillo to Albuquerque. Eighty-seven miles of 6⅝-inch J&L Electricweld Line Pipe were used in the rugged section from Palma, N.M., to Albuquerque. Performance proved conclusively that J&L Electricweld Line Pipe bends readily to contour, is easy to weld and is uniformly round. It is readily available from 6⅝ inches through 12¾ inches.

Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA

J&L Electricweld Line Pipe is produced on one of the most modern mills in the world.

Hydrostatic test is one of a series of inspections and tests given every length of pipe.

This modern J&L ultra-sonic tester assures superior weld quality.

Teletype machines help cut costly paperwork

A Teletype machine equipped with a simple sprocket-feed mechanism can handle multi-carbon forms as readily as the more familiar plain paper on which messages are transmitted. Thus distances can be bridged not only with information, but with information that is preprocessed, ready to go to work.

Teletype printers handle a wide variety of multi-copy forms. Moreover, the usefulness of this technique can be further extended with Teletype tape punching and reading equipment—which can capture, store and utilize repetitive data to further mechanize paperwork procedures.

For more information about Teletype Model 28 equipment, please write to Teletype Corporation, Dept. 92C, 4100 Fullerton Ave., Chicago 39, Illinois.

Typing Tape Punch

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See Teletype Corporation's equipment exhibit at the Petroleum Industry Electrical Association Conference, April 12-14, Kansas City, Mo.

Overlooking tank farm at Haoud-El-Hamra departure terminal across the flat Sahara desert.

hydrostatic head between the two points.

Line pipe characteristics. The pipe was electric-welded according to U. S. Standard API 5LX and was proved in individual pipe lengths of about 39½ ft per joint. Quality of the steel was X52, having an elastic limit of 520 psi. In some of the lower pressure sections, X42 steel was used with an elastic limit of 420 psi. The wall thickness is telescopic in that it varies from ¼ in. wall thickness to ½ in. wall thickness at maximum pressure points. Actual working pressure of the line is relatively high according to French standards and is set at 77 percent of design pressure in the desert regions, 75 percent in rural zones, and 67½ percent of design pressure in the urban areas. Total tonnage of pipe required was 76,000 tons.

In the spring of 1958, construction in the Bougie terminal, and in October of that year, construction commenced on the pipeline, itself, and the first intermediate pump station at M'Sila. A little over a year later, the first stage of the pipeline system was put into service. The pipe was rolled from steel plate made in French steel mills and fabricated in Germany by the large steel firm of Mannesmann.

Line divided into two projects. The construction job was divided into two parts. The south part covered relatively smooth terrain without excessive irregularity. This section included the construction through most of the flat desert to the foot of the mountains to the north. It was planned that this construction could proceed very rapidly, and spreads working on the south part were equipped with the best of materials and construction units.

The north part of the line was contrasted with irregular terrain through the Atlas Mountain range reaching an elevation of over 3300 ft. Topography was difficult, and it was also a region subjected to severe weather changes from 120 F in mid-day to near freezing at night. Mud was also an enemy of the construction crews.

Both parts of the construction phases were planned so that each would be completed about the same time. Each section was begun in the fall of 1958 and were scheduled for completion in the summer of 1959. That section in the flatter areas to the south of the mountains was to proceed at the rate of about 31 miles per month and about 15½ miles per month for the north section through the mountainous areas. The southern portion measured about 278 miles compared to 133 miles for the north portion.

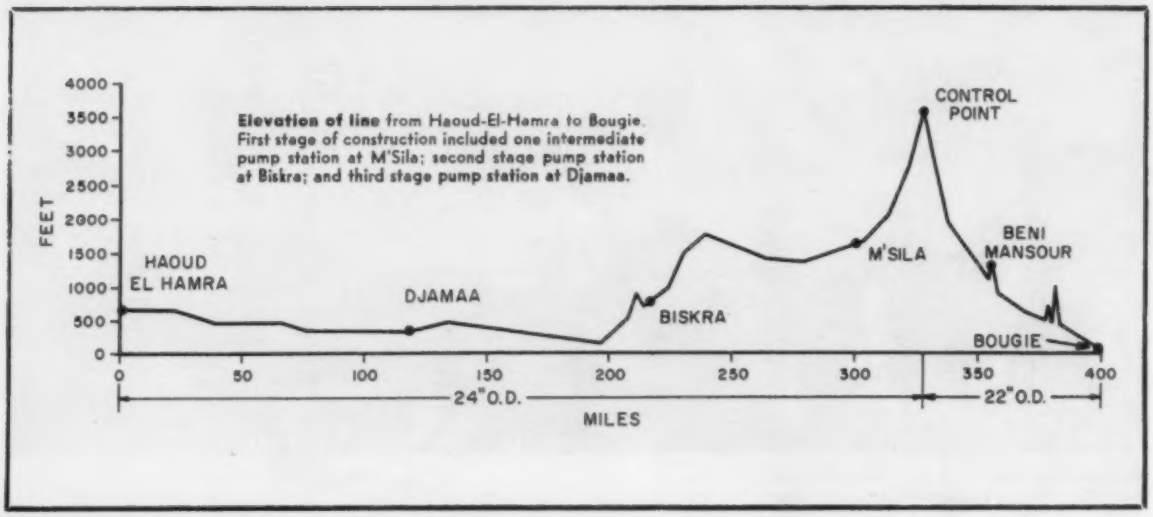
The south part of the line started from Haoud-El-Hamra on November 15, 1958, and by February 15, 140 miles of 24-in. line had been welded together for an average of 46½ miles per month or 1.55 miles per day. During this time, sand storms and bad weather prevented any work being done for a total of 15 days. So, the average was about 1.86 miles per working day. This high rate was achieved by utilizing U. S. pipeline construction methods, including automatic welding machines, and double-jointing pipe techniques at storage areas prior to stringing along the line.

The north section was started at its south point (25 miles east of M'Sila) on November 19, 1958. By February 15, 37.3 miles of line had been welded for an average of 12.4 miles per month. Unusual difficulty in this mountainous and rocky area held back progress until more experience was gained in this type construction. In the final construction stages, the rate passed 18.6 miles of line per month. Construction in this area was similar to mountain operations in the U. S. and Canada, and the crews were plagued with landslides which held up progress. The south part of the project was completed in 6½ months, while the northern section was completed in 9½ months.

The total 411 miles of line required 76,000 tons of pipe joined together by 60,000 welded joints. Between 2500 and 3000 workers were required, 2000 of which were Moslem natives. Materials and supplies came from 150 organizations of which 140 were French and ten were non-French. More than 2½ million cu yd of earth were dug for the ditch and, in the port of Bougie, 2.8 million cu yd were dredged in the dock area. Some 25,000 field and 150,000 shop X-rays were made. The line includes about 240 major valves and 18 storage tanks each of 220,000-bbl capacity.

Departure Pump Station at Haoud-El-Hamra

Within the boundaries of the northern part of Hassi-Messaoud, and on the CFP (A) concession, the Haoud-El-Hamra terminal was located. A 16-in. gathering line brought oil from the S. N. REPAL concession to the south and another gathering line brought other production from a central tank battery to the southeast of Haoud-El-Hamra. Construction of this terminal did not pose any special difficulties other than those confronting the construction crews as regards climate and logistics. Site of the terminal was on a large plateau favorable to the construction of tankage and overlooking a slope



tending downward in all directions. Basic parts of the terminal included twelve 220,000-bbl capacity tanks (of which six were installed in the first stage of construction), the pump station, a power plant, and housing facilities for operating crews.

The tank farm is situated in a large oval with the plant facilities located at the open end. All tanks are connected to a manifold system which permits any one of them to be filled from one of the lines bringing crude into the terminal from either of the two producing companies, as well as providing suction from all or any one of the tanks into the pumps. These 220,000-bbl capacity tanks are about 188 ft in diameter and 47½ ft high. Remote gaging of quantities pumped northward and of quantities received from the field also were provided at the terminal.

The pump station is of the outdoor type and is made up of five groups of electric motor-driven pumps, each of 2000 hp. The motors are directly connected to single-stage pumps installed in series. A light-gage metal roof covers the pumps and motors. Operation of the tank headers and the pump station are controlled from a console located inside an air conditioned control room.

The station is provided with auxiliary 270 hp boosting pumps vertically mounted. These pumps provide a boost in suction pressure and volume of the main pumps and prevent cavitation by insuring adequate pump suction head.

The departure terminal also included a 3750-bbl reservoir of water for fire protection use and an office building with 10 offices. A power station will be supplied fuel by natural gas and will consist at the time it is put into service (April 1960) of three groups of gas-powered turbine generators producing 6000 kw of electric power. A fourth group will be put into service in the late summer of 1960. The power station will supply 5.5 kw to the pump station by an underground cable, and will also provide power for electrical requirements in the field, as well as in the two base camps of both oil producers. Performance of the gas turbine declines rapidly as the temperature of the incoming air increases. Refrigeration facilities are provided by an evaporation unit to maintain inlet air temperature as low as possible. This will permit the maintenance of higher output from the station during the hottest hours of the summer.

The camp at this station contains 40 rooms, a bar, and a restaurant. Since the power station could not be ready for the start-up of the line scheduled for last fall, it was necessary to provide the pump station with temporary diesel motor-driven pumps for approximately six months.

Construction of Intermediate Pump Stations

Of the three intermediate pump stations, the following discussion will relate to station No. 3 near M'Sila, since it is part of the first stage of construction. Station No. 2 will be equipped in a similar manner, as station No. 3. And the third intermediate station is being studied for remote control and will be of a different type.

Principle components of these intermediate pump stations include: (1) The pump station; (2) the power station; (3) the control room; (4) the tank farm; and (5) crew quarters. The pump station at M'Sila is equipped with five 2000-hp pumps mounted in parallel. Diesel motors rotating at 1000 rpm drive the five-stage pumps at 3600 rpm through intermediate speed increasers. A flow of 13,200 bbl per hr is provided by four pumps, while the fifth serves as a stand-by. Special precautions have been taken to furnish these diesel engines with highly-filtered air to remove any trace of dust.

Power plant. Electric power for all the auxiliaries of the station are provided by a power plant. Three 1000-hp diesel motor-generator units were installed, one of which serves as a stand-by.

The control room consists of two panels, one representing the crude oil system and the other the electrical supply system. Two consoles permit control of all operations at the station.

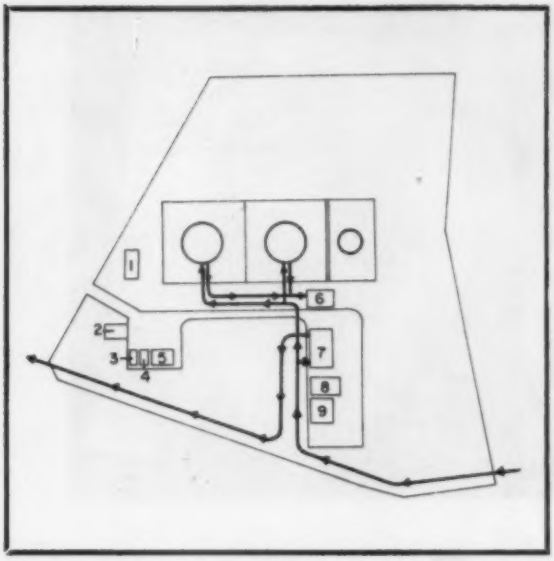
Tankage at this intermediate station is composed of two 55,000 bbl capacity tanks that will eventually serve as a buffer for the station since it is expected that continuous through pumping operations will be utilized. In this manner, oil will enter and leave the station without passing through these tanks.

Personnel quarters at this intermediate station will ultimately consist of 20 rooms and 16 apartments with a restaurant and large meeting room.

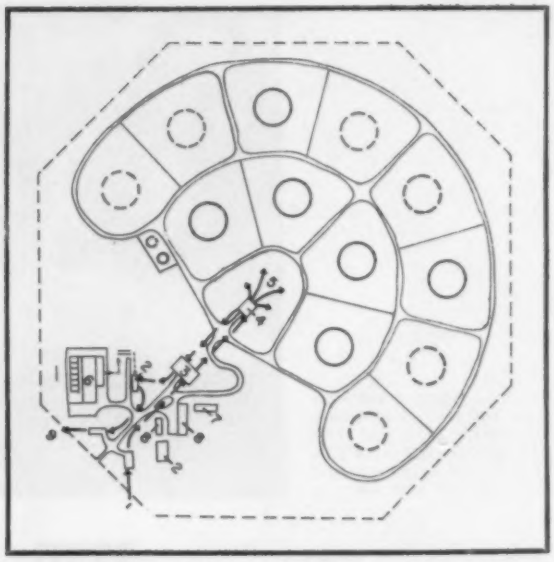
The Bougie Tanker Terminal

The Bougie terminal on the Mediterranean Coast was not an easy site selection problem. Its location was based on best route of the line from the mountains, proper availability of area for the terminal, adequate location of the large tankage required, and a suitable port situation where large tankers could come and go easily and several could be handled at one time.

The port of Bougie seemed to be best suited for the location of the



Departure terminal at Haoud-El-Hamra in Hassi-Messaoud field. (1) Crude line from field; (2) pump station; (3) booster pumps; (4) manifold; (5) lines to storage tanks; (6) power station; (7) water ponds for fire fighting; (8) offices and garages; and (9) main line to Bougie.



Intermediate pump station at M'Sila completed as part of first construction stage includes: (1) Water storage for fire fighting; (2) offices; (3) warehouse; (4) workshops; (5) garages; (6) booster pump station; (7) pump station; (8) control room; and (9) power station.

coastal terminal. It included the tank farm, a pump station, power-generating facilities, loading lines, facilities to receive tanker ballast and loading berths.

The Bougie terminal was the first installation to be started in the entire construction program. By the end of April 1958, bulldozers were leveling out the tank farm area and constructing tank foundations and dykes and roads. By June, tanks were being erected. In November 1958, construction crews began work on the buildings, the offices, the pump stations, and the power plant. Incoming lines, header systems, distribution lines, and controls were started in March 1959. Dredging of the dock area began in October 1958, and in January 1959 work started on the jetties and piles were driven for docks.

Tank farm at Bougie. The tank farm at the Bougie terminal will ultimately consist of twelve 220,000-bbl floating roof tanks identical with those at the departure terminal located at Haoud-El-Hamra in the northern part of Hassi-Messaoud oil field. The first step of this program included the construction of five tanks which represent 10 days' operation of the line. The second step of the construction will add four more tanks corresponding to about nine days of the larger flow of 200,000 bbl per day. The third and final step will add three more tanks and under the new flow at higher rates of 300,000 bbl per day will represent about eight days' operations.

The pump station is made up of seven vertically-mounted electrically-driven pumps. Six of these are capable of delivering 12,540 bbl per hr each and the seventh has a capacity of 7,850 bbl per hr. This gives the terminal a total loading capacity of 83,100 bbl per hr.

Loading lines are of 32-in. OD that assures a low pressure drop for large flows when two tankers can be loaded simultaneously in about 10 hours.

Two large open ponds of 75,000-bbl capacity were installed to receive water ballast from the tankers. The polluted water will be decanted in these basins where oil will be skimmed from the surface.

Loading docks for tankers are scheduled for early construction and are not yet completed. These docks are tied in with the second and third stages of overall construction and will be completed by 1961. The final project will consist of five docks and two underwater loading lines.

Construction of three docks are definitely underway, and they are planned to receive tankers of 45,000 tons capacity. Additional dredging is scheduled and will be adequate to accommodate access of tankers of 65,000-ton capacity.

Theoretically, the three docks now under construction will adequately handle the ultimate capacity of the entire system. But, since additional facilities may be required and to reduce the risk of delay when the third stage of construction is completed, two supplementary docks are planned to make a total of five.

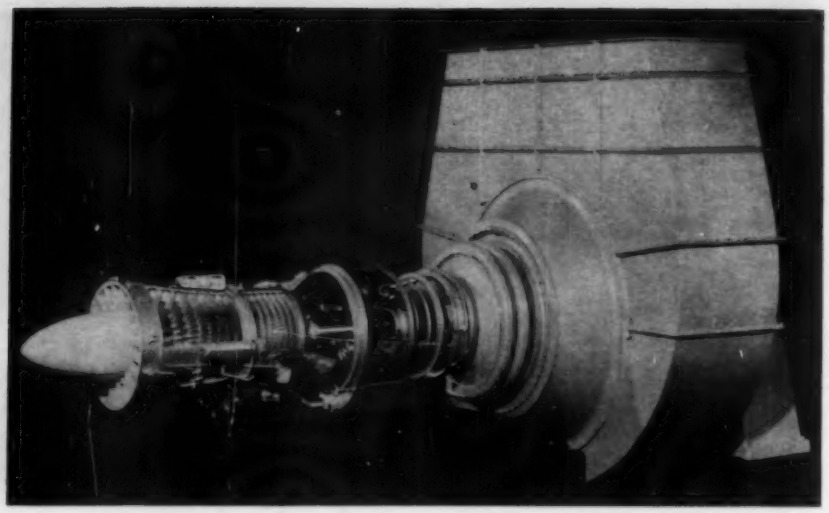
Oil Development Pushes Pipeline Construction

The Hassi-Messaoud to Bougie crude oil line is but one of three lines to transport petroleum already discovered and developed by the French in the vast expanses of the Algerian Sahara Desert. One major 24-in. line 485 miles long is now under construction from the Zarzaitine field on the Libyan border and extends up through Tunisia to the Mediterranean seaport of La Skhirra. This line is scheduled for completion later this year. It was described in the December 1959, issue of *Pipeline Engineer*, page D-19. When completed, this line will have an ultimate capacity of approximately 340,000 bbl per day.

Under construction is a 24-in. gas line from the H'R-Mel gas field (see map) located some 125 miles to the northwest of Hassi-Messaoud. This line will extend to the Mediterranean coastal city of Oran and will also tee over with a 16-in. line to Algiers. Primary purpose of the line is to supply needed fuel for industrial development of these two major port cities.

Acknowledgment

The editors gratefully acknowledge the generous help of the officers of Societe Petroliere de Gerance in Paris in providing much of the data and information contained in this article. ★



SCALE MODEL OF THE NEW GAS TURBINE SHOWING CUTAWAY VIEW OF THE GAS GENERATOR PORTION OF THE UNIT, WHICH IS THE MODIFIED JET ENGINE.

Why a JET Gas Turbine?

Engineering details of and purpose behind an experimental unit now being installed on Columbia Gas Transmission Company's system

R. L. Boyer
Vice President and Director of Engineering
The Cooper-Bessemer Corporation

RECENTLY an announcement was made that Cooper-Bessemer and Pratt and Whitney Aircraft had combined engineering and research facilities to produce an experimental gas turbine. The first turbine, a 10,500-hp test unit, is currently being installed at Clementsville, Kentucky, on the gas pipeline system of Columbia Gulf Transmission Company.

At the very start, it is logical to ask why, with all the known industrial gas turbine developments, would a prominent builder of engines and compressors combine efforts with a leading aircraft jet engine manufacturer on such a project. In the judgment of both Cooper-Bessemer and Pratt and Whitney engineers, there are many reasons why this is a logical approach to gas turbine application, and perhaps a better approach than any thus far.

Since the beginning of the application of gas turbines, particularly to gas transmission lines, Cooper-Bessemer has been making an extensive study of the gas turbine as the potential competitor to reciprocating engines and compressors. The conclusion was reached that the gas turbine in some form was here to stay. Although it would never completely replace the reciprocating engine or compressor, it was obvious that the gas turbine would find some share of the market.

As turbines were becoming more widely applied, another conclusion was evident. Some way had to be found to lower the cost of gas turbine compressor stations. And some way had to be found to enter this field without exorbitant development expenditures and excessive development time.

Cooper-Bessemer probed world-wide in their efforts to find a logical approach. A conclusion was finally reached that proved experience, talent, and facilities for designing and building, at least the gas generator portion of the gas turbine, was to be found in the aircraft industry. When comparing experiences and results in the aircraft industry, another conclusion was logically reached: That Pratt and Whitney Aircraft had all three of these basic requirements and in the greatest quantity and quality.

How Gas Turbines Work

For the benefit of those not totally familiar with aircraft jet engines and commercial gas turbines, a layman's description is in order.

Any power-producing gas turbine consists basically of an axial high-speed compressor that supplies air to combustion chambers. The combustion chambers in turn supply the energy for the turbine wheel, which ultimately drives this same air compressor.

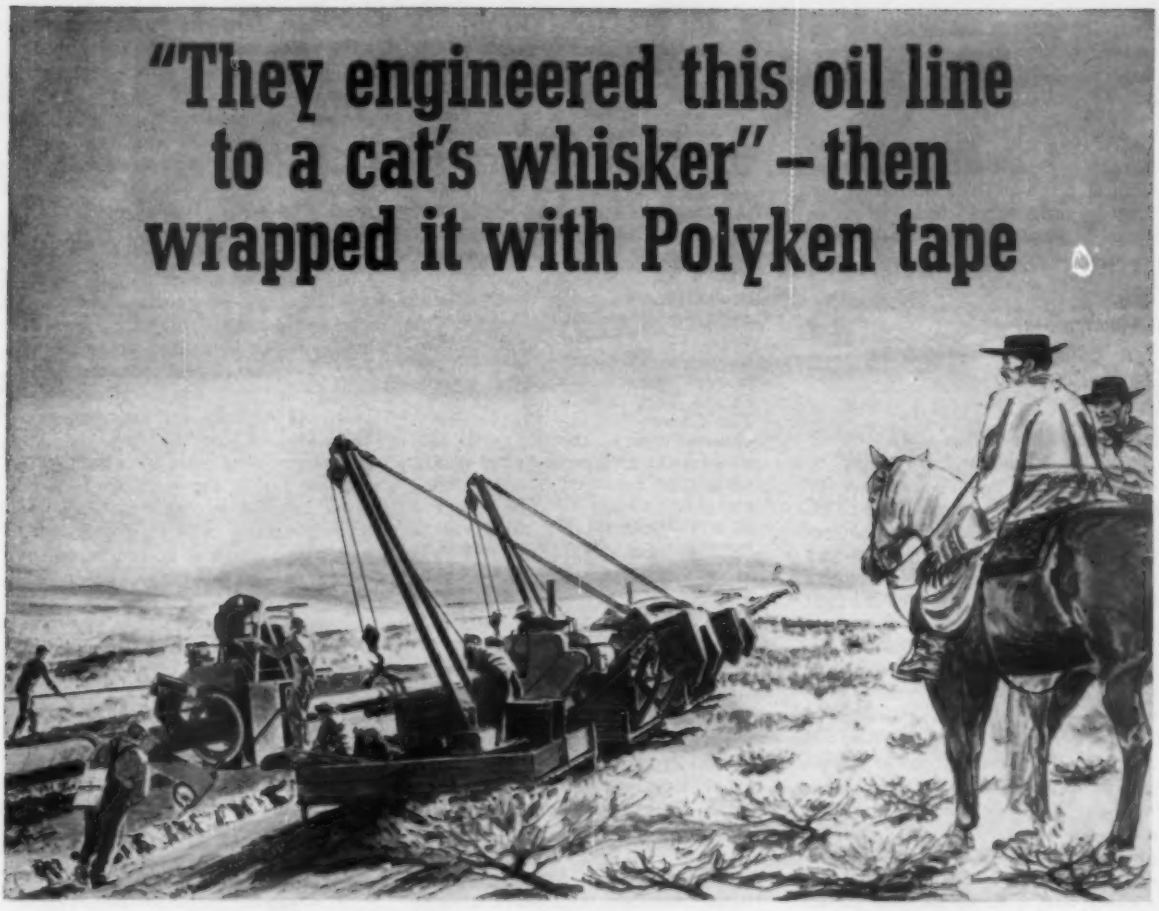
The simplest but unfortunately inefficient form of gas turbine consists of merely taking power from a single shaft machine that mounts both the compressor and the turbine.

A more efficient form of gas turbine design provides another and separate turbine, which is powered by the excess energy from the first turbine and becomes a power-producing element of the combination. In this latter case, the turbine-driven compressor with its combustion chambers becomes known as the gas generator. The rest of the machine is known as the power turbine.

The modern jet engine in Cooper-Bessemer's new concept is basically the gas generator portion of a power-producing gas turbine. In its original aircraft use, of course, the exhaust, instead of driving another turbine, produces a jet thrust that powers the plane.

The gas generator portion of the conventional industrial gas turbine unfortunately is the portion of the machinery in which the greater part of development cost, trials and errors, etc., must be expended. It is quite obvious, therefore, that in producing its jet en-

"They engineered this oil line to a cat's whisker"—then wrapped it with Polyken tape



One of the world's largest pipeline operators chooses the world's toughest tape coating for new Patagonian oil line

A leading international pipeline company recently wrapped over 100 miles of crude oil gathering and transmission line with Polyken No. 960 Extra-Strength Pipeline Roll.

The new line, which crosses part of the Patagonian plateau of southern Argentina, is an example of perfection in pipeline design. "They engineered it to a cat's whisker," is the way a seasoned pipeliner put it.

In their construction plans, the engineers specifically called for Polyken No. 960 Tape. Seven years of testing and study had convinced these people that Polyken delivers the durable, practical protection that a precision-built line needs.

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gines, the aircraft manufacturer has attained a wide experience in the development and production of the potential gas generator portion of the industrial turbine.

First item that attracts attention to the aircraft engine builder is simply experience. Experience of aircraft manufacturers measured in terms of numbers of turbines and horsepower produced is probably a hundred times greater than the combined efforts of all industrial gas turbine builders. Already in service, for example, are more than 18,000 of the J-57 jet engines, the type incorporated in Cooper-Bessemer's new power concept.

Overhauls Not Excessive

A logical question also might be whether the jet engine manufacturer has experience that is applicable to industrial gas turbines because of the possible difference in operating life and periods between overhauls. Actually there is not as much difference as might be expected. Jet engines are now overhauled after periods up to 1400 hours in the air; however, not a great deal is found to require attention at these overhauls. Periodic checks are considered necessary because lives are being entrusted to the performance of the jet engines. It is apparent that the modern jet engine is now developed to the point where its life between overhauls approaches that of heavier industrial machinery.

An observation is that the jet engine builder has been compelled to design for sudden application of full load and appreciable overloads during takeoff. Therefore, it has been necessary for the designer to observe, with greatest care, designs that permit radical changes in temperature without damage to the turbine. Still further, the jet engine manufacturer has been compelled to cope with temperatures considerably higher than have ever been used in industrial practice. His experience in engineering and materials, therefore, would indicate that he be highly capable of designing for industrial needs.

Efficiency Has Been Increased

Efficiency of the gas turbine in its highest form still falls far short of the most efficient reciprocating engines of today. There are, however, other factors in the application of gas turbines that frequently make the turbine an economic competitor to the reciprocating engine.

It is desirable in industrial practice to realize the highest efficiency possible in the gas turbine. This practice normally dictates the use of the regenerator. The regenerator is in effect a large heat exchanger through which the exhaust is passed on its way to the atmosphere and through which air is passed to reclaim the exhaust heat.

Considering the above, it is only natural that Cooper-Bessemer was determined in its search into the problem to eliminate the regenerator if possible. This is because the regenerator so greatly increases the cost of the installation. Obviously, weight-wise a regenerator cannot be tolerated on an airplane, so the jet engine builder has been compelled to do without it.

As jet engines came into commercial aircraft use, efficiency or high fuel economy became increasingly important. It was necessary that the jet engine builder, therefore, find means of attaining high fuel economies without the regenerator. Pratt and Whitney Aircraft fortunately has succeeded to the point that the efficiency of their non-regenerated aircraft jet engines is approximately equal to the efficiency of the present-day regenerated industrial turbine. They had the know-how, therefore, to attain this same efficiency in the joint industrial venture to develop the new stationary gas turbine power concept.

Maintenance Simplified

A new concept in maintenance has been introduced by the design of the first experimental gas turbine in which the two companies are cooperating. The gas generator portion, now being relatively light in weight, will be quickly removable from the power turbine. Naturally it is anticipated that the greater part of the maintenance will be on the gas generator portion. But with the new concept, the gas generator, when requiring anything but minor maintenance, will be removed and replaced by a complete spare unit. To perform the total service operation will take not over four hours. Overhaul of the gas generator may then be done elsewhere, at least not at the compressor or power station.

Costs Lowered

As indicated earlier in this article, one of Cooper-Bessemer's objectives in developing the gas turbine has been to find a way of lowering costs of equipment, installation, and operation. With the tremendous production facilities of Pratt and Whitney, this requirement is being realized.

Perhaps even more important than the first cost of the machinery will be lower installation cost. By eliminating the regenerator with its cumbersome piping and ducts, it no longer will be necessary to elevate the turbine on concrete piers or to have a basement in the building. Furthermore, the new concept will be lighter in total weight and considerably smaller in overall dimensions than present practice.

Installation cost, including the building, piping, etc., should not be more than half the traditional industrial gas turbine plant. In the case of the gas pipeline compressor station, more money probably will be tied up in the plant exclusive of machinery than in the machinery itself.

Whereas the jet-gas-turbine development is a cooperative effort between Cooper-Bessemer and Pratt and Whitney Aircraft, Cooper-Bessemer is undertaking the marketing responsibilities as well as all direct responsibilities to the customer for the entire equipment power package.

The first 10,500-hp Cooper-Bessemer turbine, which will receive all of its energy gas from the Pratt and Whitney gas generator, is being mounted on a foundation along with a Cooper-Bessemer centrifugal gas compressor. The gas generator portion itself will need little foundation.

As regenerator ducting will be unnecessary, the exhaust from the power turbine will be piped straight through the roof, further simplifying installation procedures.

Normal Noise Level

In the new concept, noise level will be no different than the conventional industrial turbine. This is because the principal sources of noise experienced in aircraft operation, namely the intake and exhaust, will no longer be directly exposed to the atmosphere. The intake will, of course, be muffled by an air filter, and the exhaust will be ducted to the power turbine. ★

R. L. Boyer *is responsible for the idea of a gas turbine involving a modified aircraft jet engine, and adds it to an impressive list of other notable achievements. Developments for which he is most widely known involve the combustion of natural and other gases in internal-combustion engines, particularly the gas-diesel and high-compression gas engines, both atmospheric and supercharged, 2-cycle and 4-cycle.*

Two years prior to graduation from Ohio State University in 1924, and two years after graduation, Boyer was employed by the Sperry Gyroscope Company on the development of the compound diesel engine. Since 1926 he has been with The Cooper-Bessemer Corporation, progressively in the capacities of diesel engineer, assistant chief engineer, chief engineer, vice president and chief engineer. On May 1, 1957, he was appointed director of engineering. He is also a director of the corporation.

His degrees are BME and ME, both received from Ohio State University.

Pipeline Projects

Files To Complete $127,000,000 Expansion

Trunkline Gas Company has filed a $45,100,000 expansion program with the Federal Power Commission, its second within a year, designed to complete the looping of its system between Longville, Louisiana, and Tuscola, Illinois.

The proposal calls for construction of 252 miles of main line loop and approximately 140 miles of supply lateral, as well as compressor station yard piping loop and measurement facilities, but no additional horsepower.

Added to the $82,000,000 expansion currently in progress, it will increase Trunkline's capacity by 335,000,000 cu ft daily at a cost in excess of $127,000,000.

The in-progress construction, which includes a 204-mile main line extension to the Indiana-Michigan state line, will increase capacity to 510,000,000 cu ft per day, and the newest proposal now before the FPC would increase capacity from the authorized 510,000,000 cu ft to 710,000,000 cu ft per day.

The 200,000,000 cu ft increase would be delivered to Trunkline's corporate parent, Panhandle Eastern Pipe Line Company, and would enable Trunkline to serve the Indiana towns of Rensselaer and Knox.

Trunkline hopes to complete the program by November.

Plans Big Storage Area To Benefit St. Louis

Mississippi River Fuel Corporation, seeking to increase the available peak supply of gas to St. Louis, Missouri, gas users, has asked for Federal Power Commission approval to construct an underground gas storage area capable of holding approximately 32 billion cu ft of gas.

The project, estimated to cost $7,800,000, would include a pipeline from the storage area to the concern's existing lines on the Illinois side of the Mississippi River.

The proposed site is an existing oil field just south of St. Jacob, Illinois, about 30 miles east of St. Louis. Mississippi River Fuel has drilled six test wells on a total of 12,000 acres leased for storage purposes in the area. Five more wells for ultimate injection and withdrawal of gas are proposed, according to Glenn W. Clark, president.

The transmission company supplies gas to Laclede Gas Company, a St. Louis distribution company, which last year filed a complaint before the FPC seeking to force Mississippi River Fuel to increase the amount of gas to be available for the utility's residential customers.

TGT, Midwestern File For Gas Expansion

Tennessee Gas Transmission Company and its wholly-owned subsidiary, Midwestern Gas Transmission Company, have filed four expansion applications with the Federal Power Commission covering about $48,000,000.

TGT's principal project, to provide an additional 204,000,000 cu ft per day required by 50 existing customers, including Midwestern, for the 1960-61 winter, would include 155 miles of 30 and 36-in. pipeline paralleling its existing system in Ohio, Pennsylvania, and New York; 72 miles of gas gathering line; and 31,300 more compressor horsepower for five stations.

In related applications, TGT proposed to install 6500 more system compressor horsepower to provide Midwestern with an additional 20,000,000 cu ft per day and Midwestern applied to sell the 20,000,000 to a new customer, Illinois Power Company.

Midwestern's largest application is to add 14,000 compressor horsepower to its system and provide 40,000,000 additional cu ft per day to Northern Illinois Gas Company and 20,000,000 more cu ft per day to Peoples Gas Light and Coke Company. It also would furnish nearly 5,000,000 cu ft per day for the combined needs of Midwest Gas Pipeline Company and Allied Gas Company, two firms planning new pipelines in Illinois.

TGT's planned construction, plus others authorized but as yet unbuilt, would increase the system's average-day capacity to about 2.8 billion cu ft per day and its peak-day capacity to 3.2 billion per day. Midwestern's capacity would rise to more than 436,000,000 cu ft per day.

Plans Gas Line To Serve Oklahoma Power Plants

A 300-mile gas pipeline system is planned by Oklahoma Resources Development Company, Oklahoma City, headed by E. C. Joullian, president, to serve power plants in the vicinity of Oklahoma City and Muskogee.

The main line, about 170 miles of 12-in. with a 50,000,000 cu ft per day capacity, will run from Oklahoma City to Harrah and Muskogee to plants of Oklahoma Gas & Electric Company which are now connected by Oklahoma Natural Gas Company.

The remainder of the system will be 4 to 10-in., including supply laterals from near Okeene in Blaine County, northwestern Logan County, and the Greasy Creek area of Hughes County.

Oklahoma Resources now serves OG&E plants at Oklahoma City and Sulphur.

A&S Gets OK to Boost Natural Gas Exports

Alberta and Southern Gas Company, Ltd., has received permission from the Alberta provincial government to boost its export of natural gas from the province, a move which the gas purchasing concern's parent company, Pacific Gas and Electric Company, expects will have a favorable effect on its proposed $338,000,000, 1400-mile gas pipeline from Alberta to California.

Alberta and Southern is one of several companies that will operate the proposed pipeline in bringing initially 415,000,000 cu ft of natural gas a day from northern Alberta gas fields to a terminus near San Francisco. If necessary approval by other Canadian and U. S. regulatory bodies is completed by this spring, as PG&E hopes, construction of the 36-in. line would begin at once with operation scheduled to begin around November 1, 1961.

International Notes . . .

The two companies that jointly own the 410-mile pipeline that brings crude oil from Hassi-Messaoud to Bougie have received through their jointly-owned corporation from the World Bank a loan equivalent to $50,000,000 to help finance continued construction and operation of the 24-in. line. The system that transports Saharan oil to the Mediterranean, begun in 1958, has been placed in limited operation by Soc. Nationale de Recherche et d'Exploitation des Petroles en Algerie and Compagnie Francaise des Petroles (Algerie). The installation of additional pumps and pumping stations, to take place in successive stages to bring the pipeline up to its design capacity of about 300,000 bbl daily, is expected to be completed during 1961. (See complete story, this issue.)

Private Spanish industrialists are reportedly negotiating with Societe Nationale des Petroles d'Aquitaine on plans for a pipeline from Bayonne, France, through Irun to Pasajes, Spain, to supply the Spanish provinces of Biscaye and Guipuzcon and the towns of Bilboa and San Sebastian.

In Italy, SAROM (Societá Anonima Raffineria Oli Minerali) plans a products pipeline linking their Ravenna refinery to Milan, with two intermediate outlets at Ferrara and Mantua.

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With the revolutionary ditcher drive, operating speed in any gear range is maintained automatically—without shifting gears or changing throttle settings—even when the work load on the digging wheel varies as much as 40%.

One throttle gives the operator complete control of output shaft speed—speed that is automatically maintained by a tail shaft governor, automatically delivered for optimum efficiency. And since the engine works easier, maintenance and fuel costs are sharply reduced.

The 318 Pipeliner with Torqmatic Converter Drive is the most advanced ditcher on the market for high-production pipeline service. Get all the facts—and check the "extras" that are standard equipment on the 318—see your Gar Wood - Buckeye dealer.

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Mountains, prairie, swamp or rock . . . if it's pipelining, it can be done efficiently and on time by Houston, a prime contractor on Transwestern's new Texas to California line.

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WATER PIPELINES

WITH THE PIPELINE CONTRACTORS

● **APV Company, Inc., 1801 Continental National Bank Building, Fort Worth, Texas.** Has been awarded contract to construct 61.4 miles of 30-in. from Pollock, Louisiana, to a point near Mangham for *Trunkline Gas Company*. Field office is in Olla. A. Vaughn is superintendent, and W. L. Huff is spreadman.

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Has underway 105 miles of 8 through 20-in. in Atascosa and Jim Hogg counties, Texas, for *South Texas Natural Gas Gathering Company*, with R. M. Jones supervising the job. Is constructing 75 miles of 6 through 8-in. line for *The Ohio Oil Company* between Albion and Samaria, Michigan, under the supervision of C. M. Hoffman.

● **Cape Construction Company, Box 423, Cape Girardeau, Missouri.** Has been awarded a contract by *Consumers Power Company* to construct 22 miles of 24-in. natural gas pipeline between Northville and Clarkston, Michigan, with field office at Northville under the supervision of Garland Mims; and 121 miles of 26-in. from the Indiana-Michigan line to Northville, with another field office at Coldwater, Michigan, under the supervision of Roy Whitworth.

● **Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.** Has in progress the construction of 20 miles of dual 32-in. lines for *Basrah Petroleum* from Fao, Iraq, to an offloading terminal in the Persian Gulf; and the construction of dual 12 and 24-in. natural gas pipeline river crossings for *Petroleos Mexicanos* between Pemex City and Mexico City in Mexico. For the latter, field office is in Minatitlan, Mexico, with Rug Stapleton as project manager.

● **Contracting & Material Company, 1235 Dodge Avenue, Evanston, Illinois.** Is laying 62.2 miles of 26 in. for *Trunkline Gas Company* from Tuscola to Rossville, Illinois. Two spreads will be used, under the general supervision of Jim McGill.

● **Engineers Limited Pipeline Company, 11858 San Pablo Avenue, El Cerrito, California.** Has been awarded a contract by *Trunkline Gas Company* to construct 137 miles of 26-in. pipeline from Rossville, Illinois, to the Indiana-Michigan border. H. H. Mehail will supervise the center spread at Medaryville, Indiana, and Jake Cheeves will supervise the north spread at Lapaz, Indiana. Has been awarded a joint-venture contract with Pacific Pipeline Construction Company for the construction of 116 miles of 34-in. pipeline for *Pacific Lighting Gas Supply Company* between Needles and Newberry, California. Lee Erlewine is superintendent at Ludlow, California.

● **R. H. Fulton & Company, P. O. Box 1526, Lubbock, Texas.** Has been awarded a joint contract with Houston Contracting Company and Western Pipe Line, Inc., to lay approximately 300 miles of 16, 12, and 10-in. trunk lateral lines in the Texas-Oklahoma Panhandle and West Texas-New Mexico area for *Transwestern Pipeline Company*. Has received a contract from *El Paso Natural Gas Company* for construction of 126 miles of 30-in. pipeline in various loops across New Mexico, paralleling the company's existing line, and has named H. A. Tinkler superintendent and has located the field office at Tatum, New Mexico. Has been awarded a contract by *Natural Gas Pipeline Company of America* to lay 28 miles of 10 and 12-in. pipe in Love County, Oklahoma, under the supervision of Bill Cohoon at Marietta, Oklahoma.

● **Grayco Constructors, Inc., P. O. Box 4147, Austin, Texas.** Has contract with *Trunkline Gas Company* to lay a 53-mile, 30-in. line between Pitkin and Pollock, Louisiana.

● **Hall Construction Company, 1105 N. Carlton, Liberal, Kansas.** Is working on a 330-mile, 4 through 12-in. gathering system in western Kansas for *Panhandle Eastern Pipe Line Company*. Supervising are Mike Bell and M. E. Banning.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has been awarded a contract by *Transwestern Pipeline Company* to lay the following: 149 miles of 30-in. from the vicinity of Corona, New Mexico, west to the vicinity of McCartys, with L. A. Young as superintendent in Corona; 55 miles of 30-in. and 89 miles of 24-in. from Corona, east to Roswell and southeast to Carlsbad, with M. L. Thompson as superintendent at Roswell; 61 miles of 20-in. and 76 miles of 24-in. from the vicinity of Fort Stockton, Texas, northwest to the vicinity of Carlsbad, New Mexico, with A. J. Slovack as superintendent at Fort Stockton; 166 miles of 24-in. from Roswell, northeast to the vicinity of Dawn, Texas; and a joint contract with R. H. Fulton & Company and Western Pipe Line, Inc., for approximately 300 miles of 16, 12, and 10-in. trunk lateral lines in the Texas-Oklahoma Panhandle and West Texas-New Mexico area. Has been awarded a contract by *Texas Gas Transmission Corporation* to lay 27 miles of 6-in. products pipeline between Woodlawn, Louisiana, and the Eunice dehydration plant, under the supervision of R. L. Silar.

● **Macco Corporation, 14409 South Paramount Boulevard, Paramount, California.** Has prime contracts with various companies to construct pipelines in various sizes through 30-in. in California.

● **Missouri Valley Dredging Company, P. O. Box 1592, Burlington Station, Omaha 8, Nebraska.** Has been awarded a contract by *Pacific Lighting Gas Supply Company* to construct the dual 24-in. pipeline crossing of the Colorado River near Needles, California. Topock, Arizona, will be headquarters. Harold H. Hubbard and Charles E. Hobbs are superintendents.

● **Pacific Pipeline Construction Company, 1632 S. Greenwood Avenue, Montebello, California.** Has received a joint contract with Engineers Limited Pipeline Company to construct 116 miles of 34-in. pipeline for *Pacific Lighting Gas Supply Company* between Needles and Newberry, California. Field office will be located at Ludlow, California.

● **Panama, Inc., 2201 Commerce Building, Houston 2, Texas.** Is working two sections on the *Trunkline Gas Company* project. The first, with M. C. "Tex" Johnson as supervisor and Marks, Mississippi, as field office, starts approximately 15 miles northeast of Lambert, Mississippi, and proceeds in a southerly direction to approximately 6 miles northeast of Shaw, Mississippi. The second section, under the supervision of Eugene Coulter, is headquartered at Union City, Tennessee. The north end (approximately 30 miles) starts near Clinton, Kentucky, and proceeds south to a point near Union City, Tennessee. The south end (approximately 30 miles) starts about 9 miles southwest of Brownsville, Tennessee, and proceeds to a point near Oakland, Tennessee.

● **H. C. Price Company, Price Tower, Bartlesville, Oklahoma.** Has two spreads working on 336 miles of 30-in. pipeline across Arizona for *Transwestern Pipeline Company*. Spread One, supervised by G. A. "Abe" Reutzel, has commenced construction from Window Rock, Arizona, headquarters working west. Spread Two under the supervision of R. L. "Bob" Ezell begins at the California-Arizona border, working east. Headquarters for the latter spread have been established at Kingman, Arizona.

● **Sharman, Allen, Gay & Taylor, Inc., 3115 Buffalo Drive, Houston, Texas.** Has been awarded a contract by *Trunkline Gas Company* to build 42 miles of 24-in. pipeline in Liberty and Hardin counties, Texas, with field office at Liberty under the supervision of E. D. Singleton. Has been awarded a contract by *Magnolia Pipe Line Company* to build approximately 32½ miles of 12-in. pipeline in Cameron Parish, Louisiana, where field office is located under the supervision of Chester Lake.

● **Sheehan Pipe Line Construction Company, 514 National Bank of Tulsa Building, Tulsa, Oklahoma.** Has received a contract from *Transwestern Pipeline Company* to construct 300 miles of 4, 6, and 8-in. gathering lines in West Texas, Oklahoma, and New Mexico. Field office for first spread is located in Higgins, Texas, under the supervision of J. W. Brown; and field office for the second spread, in Monahans, Texas, under the supervision of Boyd Douglas.

● **Stelco, Inc., 905 Barton Springs Road, Austin, Texas.** Has been awarded a contract by *El Paso Natural Gas Company* to lay an undetermined amount of various size lines in the Shamrock field under the supervision of Al Blanchard and W. K. Hancock.

● **Turriff-Burden, Ltd., (subs. Burden International, Ltd., Box 5216, Tulsa, Oklahoma).** Has been awarded a contract by the *Iraq Petroleum Company, Ltd.*, for the construction of 315 miles of 30 and 32-in. pipeline from Kirkuk to the Syrian border and connecting Rumaila and Fao. The project office in London, England, will be managed by W. T. Barker. Field construction superintendent is John H. Miller; assistant superintendent is Arnold Smith; and manager of the field office in Baiji, Iraq, is G. E. Suagee.

● **Western Pipe Line, Inc., P. O. Box 1076, Austin, Texas.** Has been awarded a contract by *Tennessee Gas Transmission Company* for the construction of 3 miles of 10-in. and 2 miles of 8-in. pipeline in Plaquemine Parish, Louisiana. Field office is in Port Sulphur. J. C. Oliver is project engineer and J. E. Buckner is superintendent.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has been awarded a contract by the *National Iranian Oil Company* to construct a 240-mile, 8-in. petroleum products line in Iran from Rey, near Tehran, northeast to Sharud.

PIPELINE PERSONALS

Jack S. Gray, Grayco Constructors, Inc., was elected president of the Pipe Line Contractors Association at the close of the 1960 convention in Los Angeles,

J. S. Gray

R. D. Sheehan

E. G. Morrison

J. W. Sharman

California. **Robert D. Sheehan,** Sheehan Pipe Line Construction Company, was chosen first vice president; **J. W. Sharman,** Sharman, Allen, Gay, and Taylor, second vice president; and **E. G. Morrison,** Western Pipe Line, Inc., treasurer. New directors are: **Aubrey Barlow,** McVean and Barlow; **Charles S. LeNoir,** C. S. LeNoir Construction Company; **Jim Howe,** Engineers Limited Pipeline Company; **Kenneth Owen,** Parkhill Truck Company; and **Roger Pentzien,** Pentzien, Inc. Holdover directors are: **R. P. Gregory,** Houston Contracting Company; **M. S. Williams,** Panama-Williams Corporation; and **John H. Williams,** Williams Brothers Company.

Joseph H. Lang, vice president in charge of transmission for the Ohio Fuel Gas Company, has retired after 45 years with the company. Lang has served as mechanic, gas measurement superintendent, general superintendent of pipelines, and assistant manager of transmission. He was elected an assistant vice president in March, 1958, and was made transmission department manager and promoted to vice president the following October.

Raymond W. Hitchman, vice president of Charleston Group Companies, has retired after 47 years of service. He started as assistant department head in gas measurement in Pittsburgh, Pennsylvania, later was transferred to Charleston, West Virginia, as assistant superintendent, was promoted to superintendent of gas measurement, and in 1946 was made vice president. Hitchman was one of the organizers of the Appalachian Gas Measurement Short Course, sponsored by the natural gas industry and West Virginia University, and has served as a member of the executive committee.

J. D. Nitzschke has been appointed assistant manager of American Oil Company's terminal department. Formerly superintendent of Amoco's Providence, Rhode Island, terminal, Nitzschke is succeeded by **M. Hanewich,** assistant superintendent.

James C. Elmore, a division engineer for Texas Eastern Transmission Corporation, has been named assistant manager in Division IV.

W. T. Bulla, director of operations, Natural Gas Pipeline Company of America and affiliates, is retiring from the company, it is reported. Bulla also is a founder and charter member of the Petroleum Industry Electrical Association.

J. F. McCarthy, Cisco, Texas, has been appointed North Texas division superintendent for Humble Pipe Line Company succeeding **W. P. Guinn,** a 40-year veteran who has retired.

George C. Nilan, safety coordinator for production and pipeline, Atlantic Pipe Line Company, has retired. He served the company for 16 years, beginning as a safety inspector.

J. A. Jackman, executive assistant to the vice president of economics and planning at Sinclair Pipe Line Company, and **L. C. Peters,** Continental Oil Company vice president, have been elected to the board of directors of Platte Pipe Line Company. Jackman succeeds **J. H. Renard** of Sinclair, and Peters succeeds **H. R. Wall** of Continental.

Robert D. Joyce has been named superintendent of the work order department at Natural Gas Pipeline Company of America. **Fred L. Scott,** resident engineer at Natural Gas Storage Company of Illinois' (an affiliate of NGPL) Herscher, Illinois, facilities, replaces Joyce as administrative assistant to **M. V. Burlingame,** executive vice president.

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EXPERIENCE MAKES THE DIFFERENCE

...and a world of experience in testing thousands of miles of pipelines makes the difference in every Williams testing job.

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PRESSURE SERVICE COMPANY

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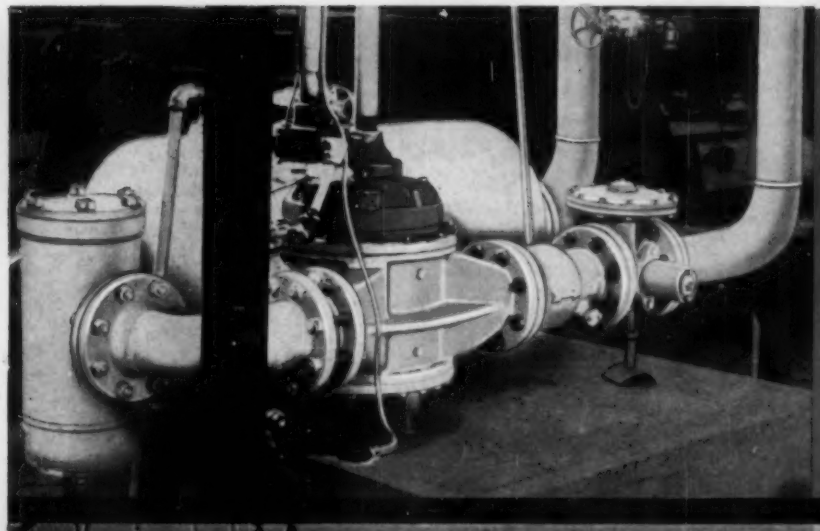
EXPERIENCED TESTING ENGINEERS

Continental Oil



SPECIAL PRODUCT LOADING
Three-inch S-35 Smith-Erie Meter assemblies equipped with temperature compensators, set stop valve, strainer, set stop mechanism and barrel counter. Printed meter ticket checks reading against refinery production.

LOADING TERMINAL
Approximately 30 Smith-Erie meters are in service loading products into trucks of Continental's customers, and tank cars for rail shipment. These meters are equipped with temperature compensators, deaerators, flow rate control valves, set stop mechanisms delivering gross gallons and printed tickets.

At Denver Terminal, separate Smith-Erie meter systems keep accurate accounting of all sales and transfers

Knowing the ins and outs and knowing them *exactly* is a must at complex product refinery-loading installations such as this one operated by the Continental Oil Company. Small wonder this progressive company "counts on" Smith-Erie meter systems for precise accounting of every drop of finished petroleum product regardless of operating conditions.

At Continental, knowing the ins and outs has a double meaning. Here, two separate operations go on simultaneously. One is intra-company distribution of the product from refinery to Continental trucks. The other is an out-sales situation involving transfer of product from refinery to trucks owned by Continental's customers. In both cases, Smith-Erie meters save costly manpower . . . provide for direct throughput . . . cut evaporation losses.

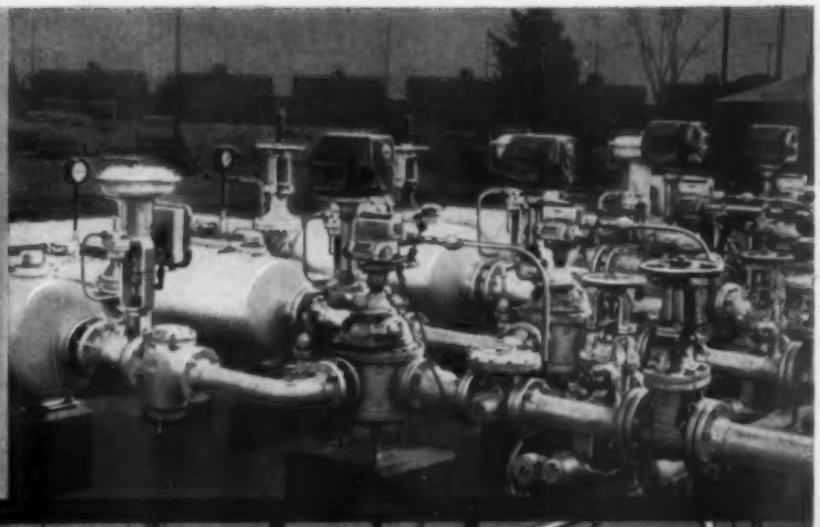
This Denver terminal is just one example of how Smith-Erie metering systems measure up to the most complex terminal requirements. For more information, contact your A. O. Smith meter man or write direct.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

meters every drop

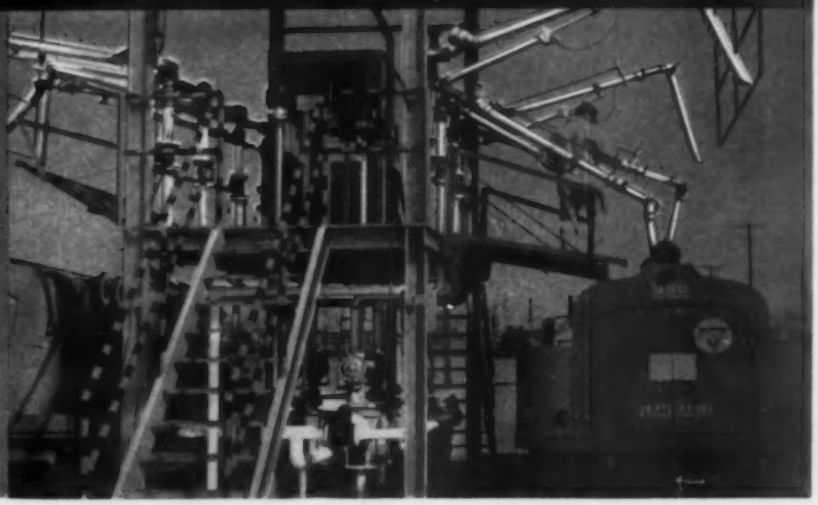
MARKETING STORAGE

Two Smith-Erie AS-35 and two AS-50 meter assemblies measure finished products from refinery production into tanks for Continental's own marketing division. Meters are equipped with temperature compensators, gross and net counters, set stop valves, deaerators and strainers. Readings are checked against refinery production and retail deliveries.



MARKETING DELIVERY

Four Smith-Erie AS-35 meters with accessories record loading of finished petroleum products into Continental trucks for delivery to Continental stations. This completes accurate record between manufacturing (refinery production) and deliveries against sales. Meters account for every drop and print a temperature-corrected record — automatically.



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A.O.Smith

CORPORATION

Smith-Erie Division

Factory: 1602 Wagner Ave., Erie, Pa. Offices: Atlanta 5, Ga.; Chicago 3, Ill.; Houston 2, Texas; Los Angeles 22, Calif.; New York 17, N. Y.; Oakland 21, Calif.; Tulsa, Okla. Canada: Toronto 12, Vancouver 1. A. O. Smith International S. A., Milwaukee 1, Wis., U.S.A.

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The original characteristics fabricated into the coating materials by their manufacturers are protected by the use of small batch kettles, filled, heated and used in rotation at Standard Pipeprotection Inc. Prolonged heating of large batches might alter the softening point, penetration and performance characteristics of the materials.

Original characteristics are further protected by electrically operated burners, electric eye control of flame, recording thermometers, thermostats to prevent over heating and cradle agitators to prevent sedimentation of the fillers, thereby eliminating any formation of coke.

At Standard Pipeprotection Inc. you get this added protection for your pipe.

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Personals

Alvin M. Hutchison is the newly appointed manager of transmission for the Ohio Fuel Gas Company. Hutchison former assistant manager of transmission for Ohio Fuel, succeeds **J. H. Lang** who has retired. Since joining the Columbia Gas System 32 years ago, Hutchison has served as field superintendent, assistant superintendent and superintendent in the gas measurement department, and has been assistant manager of transmission since 1958.

A. M. Hutchison

William A. Sullender is the new general manager of distribution for the American Oil Company in an organizational realignment that places all terminal activities under American's supply and transportation department. Sullender assumes administrative and operational direction of the company's 14 deep-water terminals, three large river asphalt terminals, and more than 50 other barge and pipeline terminals. **R. B. Rodgers** was named manager of terminals and truck transportation, **G. O. Ross** manager of distribution economics, and **W. D. Lomax** manager of terminal engineering. Assistant managers are: **J. D. Nitzschke,** barge and pipeline terminals; **W. E. Erwin,** ocean terminals; and **R. E. Looby,** truck transportation.

Byron K. Smith, formerly assistant general manager of Southern Pacific Pipe Lines, Inc., at its operational headquarters at Los Angeles, California, has been named to the newly created position of assistant to President **D. J. McGanney,** with headquarters at San Francisco, and

B. K. Smith

W. T. Eskew, Jr.

succeeding Smith in his former position under General Manager **Frank E. Kalbaugh** is **William T. Eskew, Jr.,** formerly chief engineer. Other promotions announced include: **Robert R. McDaniel** from Northern District field superintendent to chief engineer; **Charles B. Miller** from assistant to the general manager to Northern District field superintendent; **Maurice A. Huso** from electrical engineer to assistant to the general manager; **John M. Goss** from engineer to electrical engineer; and **Murray A. Levy** from superintendent of products movement to manager of products movement, without change in duties.

Carl E. Shirron has been named foreman of Texas Eastern Transmission Corporation's petroleum products terminal at Helena, Arkansas. **Clinton Roberts** replaces Shirron as foreman of the company's products terminal at Baytown, Texas, and **George Albert Neuser, Jr.,** has been moved up from control point operator at Beaumont, Texas, to succeed Roberts. **H. M. McDonald,** vice president and general manager of Texas Eastern's Little Big Inch division, announced the changes.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PIPELINE PARADE

. . . in equipment, services, sales

To Sponsor International Construction Conference

Marc B. Rojtman, president of the J. I. Case Company, has revealed company plans for an International Construction and Roadbuilding Conference to be held in Paris, France, in 1961. The news came at a "world premiere" held by the company in Bal Harbour, Florida, at which the company's entire product line for 1960 was unveiled before over 7000 Case dealers, dealer personnel, and their wives.

The Case line now covers a complete series of hydraulic-drive wheel tractors, with air-cooled all-weather cabs; the first U. S.-manufactured small diesel tractor to compete with European imports; and a full line of construction, roadbuilding and materials handling wheel and crawler tractors and equipment upon which the company will place major emphasis in 1960 and the decade ahead.

Unveiled also was a new hand and power tool line, as well as the new "Case building" that will be sold through a recently organized subsidiary, Case Building Corporation.

Heads New Gas Turbine Sales

David M. Salls, manager of gas industry marketing for The Cooper-Bessemer Corporation, has been named product sales manager for the company's RT-248 gas turbine which was developed in cooperation with Pratt & Whitney Aircraft Division, United Aircraft Company, and which is scheduled for its first pipeline installation at the Columbia-Gulf Clementsville, Kentucky, compressor station next summer.

D. M. Salls

Salls first joined Cooper-Bessemer in 1941, then became associated with Texas Eastern Transmission Corporation in 1947, returning to Cooper-Bessemer in 1951. Throughout his work at Cooper-Bessemer, his efforts have been concentrated on all phases of gas industry power and compression needs.

BIG Parsons® 420 Trenchliner...

Digs 36 to 52 in. wide... 7½ FEET deep

Today you'll find the right answer to your cross-country work and other big trenching jobs in Parsons 420 Trenchliner®. Developed especially for big work schedules, it has the extra capacity, performance and dependability you need to open trench at lowest cost per lineal foot.

Digging from 36 to 52 inches wide at depths to 7½ feet, this heavy-duty wheel-type machine produces up to 25 lineal feet of trench per minute. With all this extra capacity you still get smooth, precision wheel control. Double-action hydraulic rams actuate digging wheel — give infinite depth selections, maintain close grade tolerance in toughest digging. Heavy-duty wheel has formed steel-plate buckets, solid or tine-back, with replaceable point-type teeth.

Hydraulic control system on conveyor gives belt speeds up to 621 feet per minute — *completely independent of digging wheel speeds.* Belt easily handles maximum yardage from the extra-wide wheel — puts spoil bank well back beyond edge of trench. See Parsons distributor, or write for more facts.

Need deeper trenches on your cross-country work? Then check this larger companion model 520 Trenchliner. It produces up to 28 lineal feet of trench per minute — 40 to 52 inches wide at depths to 8½ feet. Parsons offers a complete line of wheel and ladder-type Trenchliners. In addition to the 420 and 520, there are 3 smaller wheel types — and a choice of 5 heavy-duty ladder type Trenchliners.

Mail to: PARSONS COMPANY, NEWTON, IOWA *Send literature on:* ☐ 420 Trenchliner ☐ 520 Trenchliner

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COMPANY_____

DIVISION_____

STREET_____

CITY, STATE_____

(A Division of Koehring Company) P932 PE

TRENCHLINERS for PIPELINERS

Pipeline Parade

Polyken Distributor

Midwestern Pipe Line Products Company, representative of the Tapester and REMCO pipe wrapping machine lines, has been appointed a franchised distributor for Polyken Protective Tape Coatings by the Polyken Sales Division, The Kendall Company, it has been announced by John H. Wilson, vice president of the Tulsa firm.

Detectron Rep Named

Overton Sales-Equipment Company, San Diego, California, has assumed responsibility for the line of Detectron utility instruments manufactured by Computer Measurements Company. Overton has handled this line of pipe and pipeleak detectors and box and valve detectors in Arizona and the southernmost counties of California for 3½ years.

Bucyrus-Erie Appointment

William G. Barnes has been appointed sales manager, blast hole drills, for Bucyrus-Erie Company. Before joining the company in 1956, Barnes was a mining superintendent and engineer with the Aluminum Company of America and has also served with Climax Molybdenum and M. A. Hanna Company.

Rectifier Specialist Named

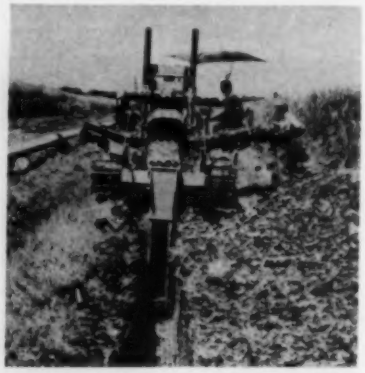
Tom Wilkinson, formerly sales manager of P. E. Stearns Company, has joined Good-All Eiectric Manufacturing Company, Ogallala, Nebraska, as a rectifier specialist. Prior to his work at Stearns, Wilkinson spent several years in the design and sales of cathodic protection rectifiers.

PIPELINE BLASTHOLER
Saves Time
Cuts Costs
Speeds Blasting
This self-propelled rotary drill unit does the work of 4 men, 2 sidebooms and 2 compressors on most pipeline blasthole operations. Mounted on tracks for terrain mobility, the BLASTHOLER drills blast holes 2 to 5 times faster than other cumbersome equipment, carries own air for cleaning hole. Standard unit drills holes from 2¼" to 3⅞" in diameter to 9' depth. Mast travels 40" laterally for staggering holes across ditch width, can be adjusted 14 degrees for angle drilling. Cut costs — speed blasting! See the BLASTHOLER today!

DRILLING ACCESSORY & MANUFACTURING CO., INC.
2006 S. Industrial Blvd. HA 8-8318 Dallas, Texas

New Line Pipe Installed

One of the first field installations of high strength electricweld line pipe made by the "quench and temper" process has been announced by Jones & Laughlin Steel Corporation. The line pipe, consisting of 10¾ in. OD API-5LX, X-52 grade electricweld with a .188 wall thickness,



was installed by the United Gas Pipe Line Company for gas lines near Edna, Texas, and Jeanerette, Louisiana. Both lines are approximately four miles long.

This high strength line pipe was produced by J&L on the electricweld mill and then heat treated. As the pipe is discharged from the heat treating furnace, it is quenched by high-pressure water sprays, then passes into another furnace where it is reheated (tempered) to achieve the necessary strength, toughness and ductility.

Expands Automation Activities

North Electric Company, to further broaden its activities in the field of pipeline automation, has appointed the Lynn McGuffy Company, Inc., of Shreveport, Louisiana, as a representative to handle sales of a complete line of automatic control and supervisory equipment. Through North Electric's integrated system approach, provisions are made in their new Paricode supervisory control equipment for data logging, handling and display and for telemetering of flow data, as well as for operation of remote unattended compressor and booster stations equipped with engine or turbine power.

Gets New IH Assignment

William T. Murphy has been named staff assistant to Clarence A. Hubert, general manager of International Harvester Company's construction equipment division. Murphy previously was staff assistant to Russell F. Denney, the division's manufacturing manager. His new assignment involves not only manufacturing functions, but also engineering, sales, and supply and inventory responsibilities, in addition to the procurement of major machines and components from other manufacturers.

Heads Everett Trencher Sales

Appointment of William (Bill) Talmadge as general sales manager of the Everett Trencher Division of Earth Equipment Corporation has been announced as the first step in an overall program of expanding the distribution of Everett Trenchers, nationally and internationally. Talmadge, with 25 years in the sales field both at the wholesale and retail levels, comes to Earth Equipment Corporation from Massey-Ferguson where he was general sales manager of the Industrial Division, U. S.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

MR-20 MOTOROLA MICROWAVE

for unequalled "on the job" performance

Motorola's *experience* in microwave design, manufacture and installation guarantees full communications satisfaction where it counts—on the job. Outstanding operational flexibility, long-life service and all-weather dependability, are service proved facts in public safety, industrial and utility applications throughout the country.

Simple "building-block" components—MR-20 RF units and associated multiplex equipment—are fitted to your exact required combination of voice, printed message, control signals and data transmission—including 2-way radio operation. Multi-channel, point-to-point operation spans any distance . . . carries your messages at low per-mile operating and maintenance costs.

What are just-right communications worth to your operations? It's easy to find out. Have your Motorola microwave representative show you on-the-job examples of full-efficiency microwave performance. Write or call today for details.

MOTOROLA ADVANCED DESIGN MAKES THE BIG DIFFERENCE

- **Automatic switchover-switchback**
- **"Hot" standby**
- **Simplified Waveguide**
- **Plus outstanding Motorola 6000 MC operational developments for optimum system performance.**

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REPAIR PIPE LEAKS
QUICKLY
PERMANENTLY
ANY PRESSURE
ANY TEMPERATURE

SKINNER-SEAL
EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

SKINNER-SEAL
COLLAR LEAK CLAMPS—for oil and gas lines. Gasket is sealed by gasket container rings—pressure is sealed in . . . air, moisture and gasket-destroying soil conditions are sealed out. Effective under any pressure. Sizes 2"—13" O.D. incl. In stock at oil supply stores!

For over half a century, a complete line of Repair Clamps and Saddles for steel and cast iron pipe. Send for catalog!

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

Crane Announces Acquisitions

Crane Company, manufacturers of valves, fittings, plumbing, and heating equipment, has entered into an agreement to acquire the operating assets of National-U. S. Radiator and simultaneously announces plans to acquire The Swartwout Company, Cleveland manufacturers of electronic control equipment.

Thomas M. Evans, chairman of Crane Company, pointed out that the acquisition of the business of National-U. S. Radiator would make a full line of plumbing and heating products available both for Crane and National-U. S. Radiator wholesalers. Crane Company will operate the business presently conducted by National-U. S. as a subsidiary or a division of Crane Company retaining present National-U. S. management and employees, under the direction of T. B. Focke, National-U. S. president. National-U. S. will receive from Crane more than $15,000,000 in cash for plants, equipment, and inventory. The sale, approved by the boards of directors of both companies, is subject to ratification by National-U. S. Radiator stockholders.

Evans announced that acquisition of the Autronic Division of The Swartwout Company, approved by Crane Company directors, would be an important factor in expediting Crane's entrance into the field of valve automation. Operations of The Swartwout Company will continue under the administration of Kenyon Swartwout and Charles Swartwout.

W. A. Songer

Crane Company also announces the promotion of Wesley A. Songer from executive vice president to president and chief administrative officer. The new president, before joining Crane, was executive vice president of American Safety Razor Corporation and earlier served on the president's staff of the General Electric Company.

Promotion Head Named

Gilbert E. Boissy has been named manager and Roger H. Booty assistant manager of advertising-sales promotion of Kellogg Switchboard and Supply Company, communications division of International Telephone and Telegraph Corporation.

Prior to his appointment, Boissy was account supervisor at P. R. Mallory and Company, Inc., and previously was director of marketing with Aetna Steel Products Corporation and marketing manager for Royal Metal Manufacturing Company. Previously employed as an electrical engineer by Automatic Electric Company, Booty has since served Kellogg in engineering capacities in research and development, central office equipment, Government telephones and industrial relays.

Kellogg also announced the promotion of Charles B. Thornley from sales supervisor of the Western region to Southeastern region manager and the appointment of Donald A. Ashford as chief engineer at the Raleigh, North Carolina, plant. Ashford previously was employed by Lenkurt Electric Company and has served with another ITT subsidiary, Standard Telephones and Cables, Sydney, Australia.

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WELDING FITTINGS
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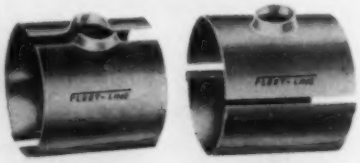
REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Full encirclement saddles.



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P. O. Box 276A • Shreveport, La.

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It's New | Pipeline Equipment

For High Pressure Gas Transmission Problems

Designed to solve problems in high pressure gas and air transmission simply, quickly, and accurately is the new Hutchison Calculator No. 3 employing the Panhandle Formula. It gives daily or hourly results and corrects for specific gravity, for pressure base, and for interval service by means of the dividing scale. One setting of rule solves all simple pipeline flow problems, and problems in looped systems and equivalent lengths are solved easily. Other features include: Pipeline constants from ½ to 40 in. ID; length from .01 to 1000 miles; and pressures up to 10,000 lb gage. Complete instructions and pressure table for 14.73 psia are included with the calculator. *Robert M. Hutchison and G. H. McKay.*

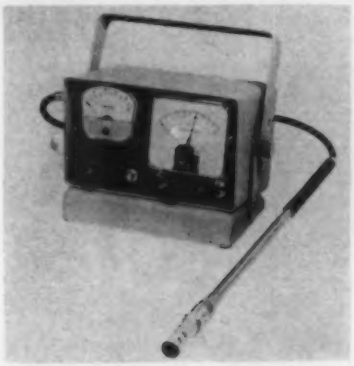
Circle number (81) on reply card.

Magnetic Separator for Submerged Arc Welding

A new magnetic separator for use with automatic and semi-automatic submerged arc welders is said to improve welder performance and weld quality by removing from flux contaminating materials accidentally picked up in handling or use. Designed for use with mild steel and low alloy steel fluxes, the separator — a funnel used to fill the flux container of the automatic welder — contains 3 cylindrical alnico magnets. Mill scale, pieces of steel, grindings, spatter, and foreign material that were picked up during the previous use of the flux are removed from the flux as it passes across the 3 magnets. *The Lincoln Electric Co.*

Circle number (82) on reply card.

Probe-Type Gas Detector



To give indication and alarm when gas concentrations reach unsafe levels, a new unit has been developed that can be operated as portable with handy probe type element and battery and charger or as fixed indicator/alarm operated directly from 110 vac source with up to 100 ft of cable to detector element. The indicator meter is calibrated in percent of lower explosion limit of desired gas. Adjustable meter trip provides alarm circuit for a built-in buzzer alarm. Auxiliary contacts are provided for external alarm or shutdown circuits. An adjustable current meter allows approximate classification of individual gas constituents in many gas mixtures. *Houston Instrument Corp.*

Circle number (85) on reply card.

Fast-Dry Coatings

Specially formulated to air-dry to touch in less than 30 min is a new line of coatings for use in a wide variety of production and maintenance applications on both metal and wood surfaces. Rust-Oleum Speedy-Dry coatings may be applied by spray, brush, or dipping techniques. *Rust-Oleum Corp.*

Circle number (86) on reply card.

For Cleaning Problems

A new cleaning aid has been introduced that may be used in tanks at temperatures between 140 and 160 F and in closed systems at temperatures between 180 and 200 F. It is a solvent additive, Acalaid, designed to be added in the range of 5 to 10 percent by volume to Oakite acidic or alkaline solutions to increase their power and efficiency in removing unusually stubborn compounded soils. The new material is neutral in pH, contains no phenols, presents no special disposal problem. *Oakite Products, Inc.*

Circle number (87) on reply card.

Non-Clog Sampling Valve

A new sampling valve is announced that is designed to deliver perfect live samples, not affected by settlement or clogging. This is accomplished by the stainless steel piston which, in closed position, completely fills the valve body and extends to inner surface of the vessel. When the piston is retracted, it leaves the entire body free for a full flowing live sample. Two compressible, replaceable Teflon rings seal the valve for a perfect closure. SV-700 sampling valves are designed for simple installation in existing systems, merely by welding a ¾-in. half coupling into the pipe or vessel, from which samples are required. They come with pipe threads, ¾-in. male inlet and ½-in. female discharge. *Strahman Valves, Inc.*

Circle number (83) on reply card.

Automatic Welding Wires

The marketing of a new line of automatic welding wires for use with submerged welding processes is announced. Alloys in this line are made from selected heats of steel, with analysis carefully controlled to fuse with the parent metal under automatic welding conditions and give comparable physical and chemical characteristics across the base metal, the affected zone, and the weld metal. Low carbon, general mild steel, high tensile steel, highest tensile steel, mild steel killed, general high tensile, and medium carbon steel welding wires are offered and are available in coils in weights of 25/30 lb, 55/65 lb, 75/100 lb, 120 or 180 lb; or in fibreboard drums of 250, 500, or 750 lb for uninterrupted production welding. *Air Reduction Sales Co.*

Circle number (84) on reply card.

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ARE YOU PLANNING REMOTE OPERATION OF YOUR ENGINES?

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HAS A COMPLETE LINE OF CONTROLS FOR

McCord Force Feed LUBRICATORS

VISUAL FLOW FILL CONTROL

Operates from central supply tank or engine crankcase.

Install in space of one lubricator feed. No machining or alterations necessary. Large sight feed shows make-up oil when called for by lubricator. Order part No. A31252.

LUB-SENTRY

Install in one pump space. Provision for pressure switch to shut down engine or sound alarm.

SIGNALS LOW OIL LEVEL OR MECHANICAL FAILURE

Contact your nearest McCord representative or write for catalog sheet McCord Lubricator Controls.

McCORD CORPORATION
LUBRICATOR DIVISION
DETROIT 11, MICH.

New Equipment

New Wheel Loader With Shovel Dexterity

Featuring lift arms and hydraulic cylinders located ahead of the operator's compartment, the first of an all-new line of wheel loaders has been introduced by Caterpillar. Powered by either a gasoline or diesel engine rated at 105 net hp and fitted with a 2 cu yd capacity bucket with tip-back angle of 41 deg at ground level and tip-back at maximum lift of 50 deg.

the new rubber-tired No. 944 Traxcavator has dumping reach totaling 31.75 in. and dumping height of 9 ft, 1.87 in. Front tires are the farthest-forward portion of the machine frame. Featured also: A 2-speed forward, 2-speed reverse, planetary power shift transmission and a manually shifted range selector transmission that provides the machine with a 4-wheel-drive work range or a 2-wheel drive travel range. The transmission is geared to provide 25 percent faster travel speed in reverse. Servicing is easily performed by hand-removal of the engine side panels. A complete line of attachments was introduced simultaneously including a side dump bucket that extends 20 in. to the outside of the left front wheel and allows dumping to the left side with a minimum of machine maneuvering. *Caterpillar Tractor Co.*

Circle number (88) on reply card.

Tone Squelch Device

A new type of tone squelch device that helps 2-way radio users avoid hearing messages other than those of their own system has been added to General Electric's Transistorized Progress Line. It is completely transistorized, contains no relays nor electromechanical devices, and may be used with both wide and narrow band TPL mobile units. Connection is accomplished with a single 9-conductor cable. *General Electric Co.*

Circle number (89) on reply card.

Encapsulated Amplifiers

A line of transistorized audio and RF amplifiers and oscillators encapsulated in blocks of epoxy resin for protection of electronic units against vibration, temperature extremes, and moisture is announced. The units are sealed under vacuum conditions. Only 2 attaching studs and bundle of power leads extend from the sealed package. Polished steel molds bonded with Teflon are used for the encapsulated device. *The Goldak Co., Inc.*

Circle number (90) on reply card.

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THE BEST PLASTIC COATING

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***"K" equals K-L-E-P-O-N**

Team up with Klepon's Korro-Kote series of baked-on plastic coatings. Don't settle for a half-baked coating application.

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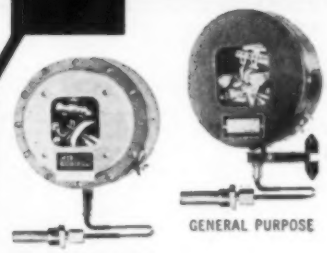
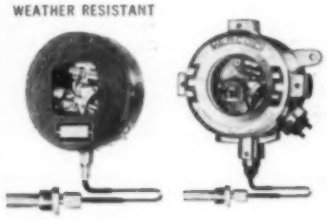
4 SERIES OF MERCOID TEMPERATURE CONTROLS





Each with these features:

External Adjustment
Sealed mercury contact
Visible calibrated dial
Visible on-off circuit
Repetitive trip point

Thirteen adjustable operating ranges from —60 +30° to 370-530°F.

Available in three case styles:
General Purpose (NEMA 1)
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Series D-35 (10A. 115V., 5A. 230V.) Double adjustments for setting both high and low (on-off) operating points.

Series D-535 (close differential type) 5A. 115V., 2½A. 230V.) Double adjustment type for setting both high and low (on-off) operating points.

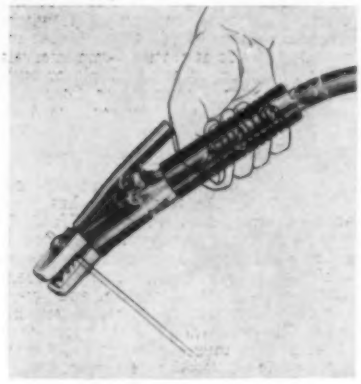
Series D-235 (very close differential type) 0.3A. 115V., 0.15A, 230V. Single adjustment for setting operating point only (minimum differential is factory set).

Series D-435 (Two-Stage Type) operates two SP-ST magnetic mercury switches at different temperatures to provide stage operation.

Write for
CATALOG NO. 860
THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

New Electrode Holder Is Air-Cooled

An air-cooled electrode holder, said to allow a man to weld a full shift without changing holders, has been introduced for heavy-duty metallic arc welding. It will



hold electrodes through ⅜-in. diam and is rated 600 amp at 40 v and 60 percent duty cycle. Air at low pressure flows from perforations in the handle. The holder is the lever-action, semi-insulated type with straight jaws as standard and offset jaws on order. The complete unit includes a 6½-ft Neoprene-encased cable whip and a "Y" connection with air inlet brazed into a Cam-Lok twist-and-lock electrical connector. *J. B. Nottingham & Co., Inc.*

Circle number (91) on reply card.

Pipe Tools Announced

A new line of copper and brass tubing tools that includes cutters, flaring tools, swaging tools, reamers, and benders, has been announced. Available in the line are: 4 cutters for hard or soft copper, brass or aluminum, block tin and lead tubing in sizes from ⅛ to 4⅛ in.; 6 flaring tools covering the range of sizes, with hard chrome finished cones and slip-on yoke; a combination flaring and swaging tool, with 4 swage adapters, complete in metal case; a regular swaging tool; 7 lever-type tube benders for sizes from ¼ through ⅞ in.; a set of 5 spring benders for sizes from ¼ through ⅝ in.; and an inner and outer reamer. *The Toledo Pipe Threading Machine Co.*

Circle number (92) on reply card.

Motor Control Centers

Motor control centers with bus capacity from 200 to 2000 amp for voltages from 110 to 600 are now available from Allis-Chalmers either as fusible or circuit breaker combination units to control electrical loads such as motors, lighting, welding, and heating. They consist of 2 or more starters fed from a common bus and are often attached to transformers or switchgear to form a unit substation. All control compartments of like size are interchangeable anywhere in the control panel. Units are said to save up to 33 percent in floor space, and can be moved from one location to another because of plug-in design. Only one main circuit breaker is needed for one center. Units have 2 doors for dual-mounted breakers to permit one to be serviced without interruption to the other, and mechanical interlocks on each door shut off current when door to cubicle is open. *Allis-Chalmers Manufacturing Co.*

Circle number (93) on reply card.

Oakite cleaning methods pay off fast. At pumping stations they help step up product flow, save time, reduce maintenance costs. Take these typical operations, for instance:

Diesel parts cleaning. A short soak in Oakite Saturol removes every trace of carbon, varnish, lacquer, gum, grease ... yet hand brushing is eliminated.

Lube oil cooler maintenance. Oakite Compound 85 does double duty — removes both grease and scale in a single operation. Units go back on stream faster, and at full rated capacity.

Cleaning electrical equipment. For maintenance of generators, control panels and electric motors, Oakite Composition 117 is the specific-purpose solvent with the two essential qualities you want: high flash-point and quick loosening of soil.

These and similar operations at pipeline pumping stations are discussed in a new Oakite Service Report, B6878. For a free copy of this helpful report, write to Oakite Products, Inc., 51A Rector Street, New York 6, N.Y.

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New Equipment

Portable, Secondary Time Standard

A portable, self-powered secondary time standard has been developed for use as a highly accurate time source and for "on-off" control of recording and telemetering equipment in remote locations at precisely timed intervals. Linking of the instrument with metering equipment used to record flow, viscosity, temperature, etc., of oil or gas moving through pipelines also is in its wide range of applications. The unit's 3-band transistor radio receives signals from U. S. government-operated "time source" stations. Special decoder, in radio's circuitry, synchronizes cordless clock to an accuracy of approximately plus or minus 16 sec per year. The unit can supply a switching function at 15, 30, 45 or 60 sec intervals, and also at precise 5-min intervals up to one hour, or any multiple or multiples of 5 min. *Zenith Radio Corp.*

Circle number (94) on reply card.

New Two-Way Radio Unit

A 100-w unit to operate in the low band (25-54 mc) frequencies has been added to the transistorized MOTRAC 2-way radio line. The new unit will accommodate either positive or negative vehicular battery ground polarity. Transistors are used in all receiver and power supply circuits and in 2 transmitter circuits. The unit will draw no more than .5 amp plus intermittent crystal heater drain while on standby. *Motorola, Inc.*

Circle number (95) on reply card.

"Work-Styled" Tractor

A new "work-styled" Caterpillar D6 Series B tractor incorporates these major new features: A completely new, compact engine that delivers 93 flywheel hp at 1600 rpm and gives the tractor 25 percent greater lugging ability; 2 new hydraulic control units that are now integrally mounted; a tilt cylinder for special applications; an optional transmission for jobs calling for higher drawbar pounds pull, and an all new operator's compartment. The all-new gasoline starting engine with off-track recoil starter is standard. This new engine develops 15 hp. Fuel capacity is sufficient for a complete work shift, fuel tank capacity having been increased to 65 gal from 48 gal on previous models. *Caterpillar Tractor Co.*

Circle number (96) on reply card.

Pipe Protection Tape

Designed for conformability over a broad temperature range, with optimum properties for pipe corrosion protection, is a new polyvinyl chloride pressure-sensitive pipe protection tape that can be applied without heat, tools, or special skills at temperatures as low as minus 5 F. "Scotchrap" No. 40 is said to give positive protection of joints, tees, couplings, and other irregular shapes. High insulation resistance and electric strength remain stable in the presence of water. Movement of soil or pipe will not cause displacement. It is not affected by fungi or mold. *Minnesota Mining and Manufacturing Co.*

Circle number (97) on reply card.

NEW PIPELINE LITERATURE

Free Technical Films

Copies of the new revised edition of the illustrated "Business and Professional Film Catalog," which lists 16 mm-sound films available on free loan to technical groups, professional audiences, and other groups with specialized interests, are being distributed free. Included are films that would be of interest to pipeliners, covering such subjects as continuous buttweld steel pipe, plastic pipe, and earth moving and construction equipment. *Modern Talking Picture Service, Inc.*

Circle number (98) on reply card.

Pocket Reference On Construction Equipment

Designed for pocket reference is a new 24-page, 4-color folder depicting in brief form the complete line of International construction equipment — crawler tractors in 6 power classes, Payscraper and Paywagon units, Payhaulers, Drott 4-in-1 rigs, Superior sidebooms, hydraulic and cable dozer and grader blades, tractor-drawn scrapers, cable control units, push plates, and 24 diesel and carbureted engines. *International Harvester Co.*

Circle number (99) on reply card.

Gas Welding Hand Torches

Gas welding and cutting hand torches, outfits, tips, and accessories are the subject of a newly revised 36-page catalog. Included are specification charts on Airco welding and cutting tips listing all pertinent information that a user might need to make proper selection for both general purpose and special gas welding and cutting. *Air Reduction Sales Co.*

Circle number (100) on reply card.

Hose and Fittings

Hose types . . . and a selector chart listing the various applications and fluids for which specific hose types are recommended . . . are featured in a new catalog that is available with either plastic binding or with a Kalamazoo-punched back for easy inclusion in parts counter record systems. The catalog also contains descriptive information about fittings, adapters, self-sealing couplings, and miscellaneous items such as support clamps and protective sleeves. *Aeroquip Corp.*

Circle number (101) on reply card.

Synthetic Parts

A new folder tells the story of how Grove developed special facilities to produce rubber parts exclusively for Grove equipment and illustrates precision presses and manufacturing procedures that produce such synthetic rubber parts as diaphragms in Grove Powreactor Dome regulators, expansible tubes in Flexflo and Chexflo valves, and "O" rings in Seal-O-Ring gate valves. *Grove Valve and Regulator Co.*

Circle number (102) on reply card.

The MINIATURIZED-PRECISION WILKINSON Line Locator Model W-3

This radically new, super-powered, transistorized instrument weighs only four pounds and is one-fourth the size of conventional pipe locators.

It is as handy as a flashlight; the maintenance is trivial; the non-leak miniature batteries last ten times longer. Long-life transistors eliminate replacement. Molded glass fibre cases. Transistor ear set. Telescopic aluminum handle. Etches circuitry and unique antenna. Contained in carrying case.

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New Literature

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1959 Annual Index.

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Welding Accessories

Arc welding accessories and supplies — including headshields, grinding shields, goggles, cleaning tools, electrode holders, cable connectors, ground clamps, work holding clamps, welding cable, protective clothing, and welding gloves — compose a new 16-page catalog. *Hobart Brothers Co.*

Circle number (103) on reply card.

Temperature Controls

Explosion-proof controls — indicating, non-indicating, and recording for temperature ranges up to 1100 F — are the subject of a new 2-color, 4-page booklet in which it is explained that the electric controls are made explosion-proof by isolating the electrical circuits and switching mechanism in a compact die-cast aluminum case mounted directly over the instrument body. *The Partlow Corp.*

Circle number (104) on reply card.

Magnetic Tape Storage

Two Burroughs Datafile magnetic tape storage units . . . one the 220 multiple-tape unit with a capacity of 50,000,000 digits . . . are featured in 2 new brochures. Bulletin 5228 describes the 220. Bulletin 3209 describes and gives typical applications of the 205 Datafile. Datafile is 1 of 2 types of auxiliary magnetic tape storage used with the Burroughs 205 and 220 electronic data processing systems. *ElectroData Div., Burroughs Corp.*

Circle number (105) on reply card.

New Computer Specs

Complete specifications on the new RPC-4000 fully transistorized, electronic, stored program, general purpose computing system, for both engineering and business data processing, are given in a catalog sheet now available. The basic system consists of the computer and a punched paper tape typewriter input-output unit. *Data Processing Div., Royal McBee Corp.*

Circle number (106) on reply card.

Controls Catalog

Mercury switch equipped controls for single-stage pressure, 2-stage pressure, differential pressure, single-stage temperature, 2-stage temperature, liquid level and mechanical movement are illustrated and described, with specifications and engineering data, in the new 56-page Mercoid Control Catalog for 1960. *The Mercoid Corp.*

Circle number (107) on reply card.

Pictures Compressor Data

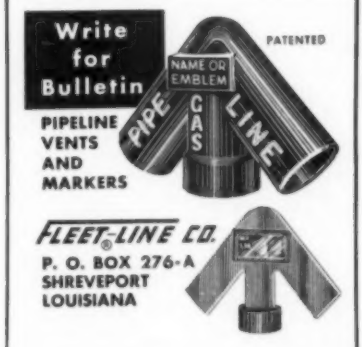
Pictured in a new 4-page, 2-color bulletin are 22 features of the Le Roi sliding vane type, 2-stage, 2280-lb model 125RG2 portable rotary compressor that delivers 125 cu ft per min of air at 100 psi at 1600 rpm. *Le Roi Div., Westinghouse Air Brake Co.*

Circle number (108) on reply card.

Alloy Chains

Specifications and suggested working load limits for single, double, triple, and quad branch alloy slings, miscellaneous slings and alloy chain attachments are given in a new 16-page bulletin on TM alloy chain and sling chains. Included are complete recommendations for inspection, care, and use. *S. G. Taylor Chain Co., Inc.*

Circle number (109) on reply card.



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PIPE-WRAP TAPE
Positive Protection for Buried Pipe
Here's pipe protection by the roll. Pipe-Wrap is made of stretchy, inert polyethylene with a pressure-sensitive adhesive to provide a tough, continuous barrier against rust, acids, alkalis and electrolytic currents. Saves time and money.
MANUFACTURERS AGENTS WANTED FOR SOME SELECTED AREAS
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CONCO 1245

Non-Flammable Cleaner

For EFFECTIVE

Equipment Cleaning

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. . . *Compressor Stations*

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for BETTER cleaning of

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Pipeline Cleaners Co.

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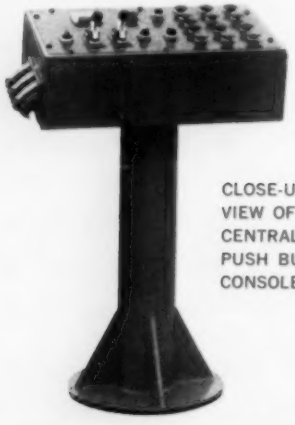
16" to 36" CROSE
internal cleaning and coating machine
. . . for sale or lease

WITH THESE SPECIAL FEATURES . . .

- Only two basic cleaning heads required for all pipe sizes from 16" through 36".
- Retractable brush unit minimizes pipe entry damage. Pressure of high speed circular wire brush indicated on operator's console — for easy adjustment during operation.
- Large capacity continuous operation vacuum pickup system removes refuse during cleaning and coating operations.
- Airless type coating spray system utilizes hydrostatic pressure to atomize paint . . . eliminates 90% of overspray and coating bounce-back.
- 360° spray head eliminates build up or lap at juncture of spray pattern.
- Operator controls machine operation from centralized push button console . . . he does not have to ride boom car.



CLOSE-UP VIEW OF CENTRALIZED PUSH BUTTON CONSOLE.

CROSE announces the newest development in pipeline construction equipment. The Crose internal cleaning and coating machine is the fastest, most efficient machine on the market, requires only two basic cleaning heads for all pipe sizes from 16" through 36", and is available on a for sale or lease basis. This electric-driven machine comes complete with pipe handling and spinning rack. Requires a minimum crew of four men . . . can be moved easily from one job site to another, or can be permanently installed.

WATCH FOR ANNOUNCEMENT OF DEMONSTRATIONS IN TULSA AND HOUSTON.

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